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# USSR Report

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No. 112



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23 July 1979

# USSR REPORT

## BIOMEDICAL AND BEHAVIORAL SCIENCES

No. 112

This serial publication contains articles, abstracts of articles and news items from USSR scientific and technical journals on the specific subjects reflected in the table of contents.

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LODGING OF GRAIN CROPS AND ITS DETECTION BY AERIAL PHOTOGRAPHY

Moscow ZASHCHITA RASTENIY in Russian No 4, 1979 pp 32-33

[Article by V. Ye. Budanov, senior research fellow of the All-Union Scientific Research Institute of Cybernetics]

[Text] Lodging of grain crops is caused by different factors: selection and genetic, agricultural technological, agrochemical, climatic and others. As a rule, lodged plants are depositories of harmful organisms which considerably decrease the yield and quality of grain crops. In addition, biochemical processes occurring in lodged plants, in ears and kernels, result in considerable loss of yield by 15 to 30 percent and sometimes even over 50 percent. This whole process of yield loss, the first visible signs of which in the field are the lodging and "honeydews", represents, as the Academician of the All-Union Academy of Agricultural Sciences imeni Lenin M.S. Dunin has defined it, a phenomenon of fermentative mycotic exhaustion of the grain. Both in our country and abroad specialists know little about it.

It has been found that in several basic areas of grain production (northern Caucasus, nonchernozem areas, Kazakhstan, Ukraine, Belorussia and others) fermentative mycotic exhaustion especially increases under the influence of rainy weather, incessant dews and fogs.

According to the data of M.S. Dunin and specialists of his school (E.I. Buryakova, G.V. Kan, S.K. Temirbekova, M.A. Gludman, A.F. Yarenko and others, 1977), investigations begun in various areas of the country in 1973 have made it possible to determine the basic features of the complicated biological mechanism causing the appearance, development and occurrence of the described phenomenon. The pathologic process, as is defined by the above scientists, occurs and develops under a certain combination of external and internal factors coming through successively and consists of the two following stages.

The first stage is noninfectious and occurs during the phase of milk, wax and, less frequently, full ripeness of grain when the ears are moistened by rain, fog or continuous dews (with irrigated crops, during late watering when the grain is being formed). The activity of hydrolytic enzymes in grain exceeds

the standard by 50 to 500 percent. As a result of fermentative hydrolysis, the carbohydrates, proteins and some products of photosynthesis accumulating in the grain during the ripening are destroyed. Water-soluble active substances (sugars, products of the destruction of proteins, etc.) formed thereby increase the inflow of water into the grain from its moistened surface (due to the difference in the osmotic pressure of these substances); this, in its turn, furthers the decomposition of the reserve nutrients. These processes cause the increase of hydrostatic pressure in the caryopsis cells which often results in the ruptures of cell walls and in longitudinal fracturing of seed and fruit envelopes; some water-soluble products appear and moisten the surface of caryopsis and the adjacent parts of the ear. This sweetish liquid which is called "honeydew" indicates the intensity of hydrolytic development in caryopsis.

Along with the hydrolysis, the respiration in the endosperm of caryopsis intensifies considerably. Carbon dioxide formed in the process volatilizes through fractures, ruptures and pores. Water that appears in the respiration process increases the hydrolytic and oxidizing processes in caryopsis. These "chain reactions," which recur depending on weather conditions, cause very substantial losses of the dry substance and a drop in the crop quality. Commonly losses of the dry substance caused by oxidizing and hydrolytic processes in caryopsis considerably exceed the damage caused by hydrolysis alone (efflux of "honeydew"). The intensity of these processes depends on weather conditions, and the greatest possible activity is observed when the moistening of caryopsis is high, up to 100 percent, under the temperature of 20-25° C. Minimum moistening of caryopsis in sunny dry days furthers the increase of photosynthesis; this provides partial or full reduction of the dry substance. Depending on the weather conditions, there can be several similar transitions from oxidizing and hydrolytic processes to photosynthesis during the phase of milk--full ripeness of grain.

Elements of anthropogenic nature play a substantial part in these processes; these elements have an effect on the pace and simultaneity of mass maturing or complete ripening of grain in ears, swaths, heaps, etc. In this case the control over the occurrence and development of fermentative mycotic exhaustion of grain in the field and the timely prevention or reduction of its harmfulness play an enormous role.

The second stage is infectious, it is caused by saprophyte and semi-parasitic fungi from the genera of *Alternaria*, *Cladosporium*, *Helminthosporium*, *Fusarium*, etc. Sugars formed as a result of the Hydrolysis and the products of fermentative destruction of proteins make an ideal culture medium for these fungi on the ear pellicles, on the caryopsis and inside it. Saprophytes and parasites destroy the nutrients and lower the crop quality, and some of them even anticipate toxins which afflict mucous membranes and digestive organs of the warm-blooded animals and man. Moisture, particularly when it lingers in caryopsis and ears furthers the growth and development of these fungi. It has been registered that the loss in grain yield caused by fungi may be as large as 15-20 percent with the drop moisture on the leaves and 60 percent with the drop moisture on the ears; the quality of the crop that has survived therewith gets considerably worse.

Thus, the main causes which bring about the occurrence and development of fermentative mycotic exhaustion of grain during the phase of milk-wax and, to some extent, full ripening are the low level or weakening of photosynthesis and other physiological processes in caryopsis; high and lasting moistening of the ears and herbage under the temperature of 20-25° C; as a result, strong manifestation of harmfulness of a group of organisms, primarily the agents of fungus disease, as well as the effect of weeds which are the foci of lasting preservation of moisture and depositories for a number of secondary pathogenes (organisms which develop in weakened plants).

The manifestation and development of this complicated pathologic process is characterized by a high level of dynamism and depends, as was indicated above, on the weather and anthropogenic factors, primarily on irrational and nonstandardized placement of fertilizers, increase in the rates of seeding, wrong irrigation and prolonged periods of the full ripening of grain crops and harvesting.

It has been registered that wherever these violations occur, the lodging of grain crops is observed most frequently, and the lodged grain crops are affected by fermentative mycotic exhaustion of grain by 2-4 times more intensively than standing grain crops. This is particularly noticeable during the so-called third (facultative) stage of exhaustion when under the conditions of lasting moisture and prolonged harvesting the grain germinates in the standing ear, in swaths and even in heaps.

Selective-genetic, agrotechnical and agrochemical measures are most important among the multi-approach protective measures which prevent the appearance and limit the harmfulness of fermentative mycotic exhaustion of grain. Measures which prevent the lodging and accelerate the complete ripening of grain, thus reducing the periods of the crop ripening, are equally important.

Timely and proper presowing soil tillage which allows for the minimization of weediness of whole areas plays a large role. The system and quality of the placement of mineral nutrition are equally important.

Timely and reliable control over the quality of agricultural work and the state of sowing is an imperative condition for the prevention of the lodging of plants.

The current system of information gathering is based on a very inexact visual survey of 10-15 percent of the whole field or area, with the subsequent interpolation of the received data on the whole crop of an agricultural zone or region.

The problem can be solved by means of remote control over all sown areas, based on the application of quantitative physical-optical methods of information gathering.

Let us examine how aerial photography can help exercise control over the early lodging, the dynamics of its development and the causes which bring about the lodging of grain crops.



The photographs show the consequences of an irrational placement of organic fertilizers during the presowing period. On the strips and spots with a surplus of fertilizers, excessive growth of plants during the period of ontogenesis is observed, the level of their immunologic protective reactions decreases and the stalk weakens; this results in an early occurrence of the lodging (in its initial stages), as well as in a considerable accumulation and high degree of harmfulness of the whole set of pathogens. One of the photographs shows the aftereffect of the tillage of stalk remnants in the stacking area: it changes mineral nutrition and brings about the appearance of weeds which, in its turn, results in the weakening of the crop and facilitates the appearance of the centers of harmful organisms.

As a rule, sowing must be conducted within the best and short periods. This allows the utilization of temperatures and water supplies which are most beneficial for the germination of seeds. It is vital to utilize several sorts of a crop which bear genetic and selective attributes of their immunity to both the set of pathogens and the lodging. It is expedient that the periods of ripening of the sown sorts be different, since it will allow for maneuvering protective measures and technology during the harvesting in accordance with the stages of ripening.

It is extremely necessary to maintain the stages of presowing treatment of seeds in order to ensure a better quality and homogeneity of seeds and to increase the germination energy and general immunity to abiotic and biotic factors.

High effectiveness in creating conditions for the appearance of good young growth and for the reduction of losses under adverse factors in Volgogradskaya Oblast has been demonstrated by the presowing wetting of seeds in tur solution (4 kg/t) and by two-stage low-capacity (2-4 kg/ha) sprinkling of the herbage by this preparation (this made the stalk almost half as long and excluded the lodging completely), as well as by the sowing with a simultaneous placement in the bed of the seed furrow of a set of mineral fertilizers and pesticides which prevent the infestation of seeds and plantules by soil-dwelling pathogens.

During the sowing period it is necessary to exercise stringent control over the rates and the quality of sowing. Excessive rates of seeding and cross sowing in turning and edge strips adjoining the roads should be eradicated. As a rule, it is in the turning strips and the bands shutting off the motion of sowing combines and fertilizer dispersers that the early and stable lodging of herbage is formed and the subsequent fermentative mycotic exhaustion of grain develops.

The photographs show the results of the violation of agrochemical and agro-technical measures during the presowing and sowing periods. The appearance of lodging and the dynamics of its development are especially clearly seen in those sowings of spring and winter barley, rye, oats and other crops where all the above violations of agrotechnology have occurred.



A great role in the reduction of the harmfulness of lodging and fermentative mycotic exhaustion of grain is played by their early diagnosis based on a prompt gathering and analysis of the objective source information on the state of crops in large areas. Data on the first signs of lodging in big areas of grain crops makes it possible to introduce timely a system of preventive, protective and other measures and to reduce the yield loss. Such measures include preventive treatments by tur and magnesium chlorate which reduce the wetness of grain, increase the strength of the stalk and accelerate the ripening by 5-7 days. Leaf feeding by a 20 percent solution of ammonium nitrate reduces the preharvesting moisture of grain by 5-10 percent, accelerates the ripening by 5-7 days and increases the protein content in the grain by 3-4 percent and the grain crop by 1.8 quintal per ha (see the journal "Vestnik sel'skokhozyaystvennoy nauki," 1977, No 7).

Early diagnosis of the lodging will also allow for conducting some preventive measures against a combination of harmful organisms and weeds characterized by a high level of harmfulness in the conditions of lodging and for determining more accurately the timing and type of harvesting, thus preventing an increase in the yield loss caused by fermentative mycotic exhaustion of grain.

Depending on the weather conditions, information on the state of grain crops in the Southern zone of the RSFSR must be gathered by means of air survey and aerial photography in the following periods.

1. Preliminary visual (with aerial photography of individual fragments, if necessary) appraisal of the quality of presowing soil tillage and of the quality and method of the placement of fertilizers, as well as an appraisal of the state of grain herbage wintering: September--October. Visual appraisal of the state of winter crops after wintering: March--April.

The results of these surveys will make it possible to identify those sowings of winter crops which are the weakest with respect to phytosanitary condition and to determine principal ways of improving their conditions.

2. Large-scale and medium-scale photography of the areas sown with grain crops: second and third ten-day periods of May and first and second ten-day periods of June. Photographs made in May will make it possible to detect the early stages of lodging, while those made in June will allow the control over its dynamics in order to improve strategy and tactics for harvesting.

Photography with the utilization of color spectrozonal films, as well as spectrometry, obtainment of television images, thermal survey etc., are of certain scientific interest. However, the results of preliminary investigations show that aerial photography with the utilization of black and white films is the simplest and most accessible for identifying violations of agro-technical and agrochemical measures and signs of early lodging of grain crops.

Particular practical value of the suggested method of control over phytosanitary condition of the sowings of grain crops and early diagnosis lies

in the objectivity and promptness of the obtained initial material and in the possibility of phytosanitary control over large areas. The ground signal service cannot actually embrace all needed areas within short periods of 2-3 days. It is precisely within such periods, however, that under the conditions favoring fermentative mycotic exhaustion of grain the yield loss may amount to 7-12 quintals per ha, which is equal, in fact, to the yield increase ensured by the placement of mineral fertilizers. Under such conditions it is hard to overestimate the role of prompt and objective information on the phytosanitary condition of grain crops obtained by aviation methods.

Captions from Back of front page

**AERIAL PHOTOGRAPHY IS A RELIABLE AND EFFICIENT METHOD OF DIAGNOSING THE LODGING OF GRAIN CROPS**

1. Early lodging of winter wheat (light colors) in a turning strip as a result of violations of seed sowing rates.
2. Lodging of spring barley (even red zones are non-lodged plants, long yellow spot is a straw stack).
3. Lodging of winter wheat during the phase of full ripeness (yellow spots are stacking places with weed growth, even red zones are non-lodged plants).

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## AGROTECHNOLOGY

### CONTROL OF MOUSELIKE RODENTS

Moscow ZASHCHITA RASTENIY in Russian No 4, 1979 pp 38-39

[Article by V.K. Belov, director of the Main Administration for Plant Protection of the RSFSR Ministry of Agriculture, and V.N. Suvorova, chief agronomist]

[Text] An extremely favorable combination of weather and feeding conditions for the growth of mouselike rodents in the most part of the European territory of the RSFSR in the fall and winter of 1977 resulted in a drastic increase in their population and their spreading in agricultural areas. Rodents populated, to a variable degree, 8.6 million ha, including 3.5 million ha in the northern Caucasus, 1.9 million ha in the Volga region, 1.2 million ha in the central chernozem areas, 1 million ha in the nonchernozem center and 0.4 million ha in the Volgo-Vyatskiy region. Such a wide propagation of mouse-like rodents has been registered for the first time in the last few years. The size of their population in the centers located in the areas sown with perennial grass and in meadows and pasture lands in Krasnodarskiy Kray, Kabardino-Balkarskaya, Bashkirskaya and Chuvashskaya ASSR's and Moskovskaya, Orlovskaya, Bryanskaya, Kaluzhskaya and Gor'kovskaya Oblasts reached 1200-6000 and more inhabited burrows per ha.

In order to protect winter crops, perennial grass, orchards, tree plantations, forage and food products, it was necessary to exert effective control of rodents during the fall-winter and spring periods of 1977-1978. This control was being carried out in accordance with methodological instructions. Specialized units and brigades were organized in kolkhozes and sovkhoses. Members of these units and specialists of enterprises in charge of plant protection were taught the methods of examination and effective control of vermins. The whole work on the extermination of rodents was supervised by operational headquarters or special commissions set up in oblasts, krays and autonomous republics and in the areas of mass propagation of mouselike rodents.

Specialists of the enterprises and signaling stations were conducting a continuous observation of the rodents' growth; overall survey of agricultural lands was organized for the purpose of identifying areas subject to treatment. Specifically, about 18 million ha were surveyed in the fall-winter of 1977, over 14 million ha in the spring of 1978 and about 15 million ha in the fall of 1978. Surveys allowed for specifying the amount of work on the control of rodents.

In addition to chemicals, biological means were used too. Production of bacterodencide was organized in 15 biolaboratories of the stations for plant protection in 1977 and in 17 in 1978. It was also produced in veterinary laboratories and in interenterprise biolaboratories.

Mechanized units of the stations for plant protection of the "Sel'khoztekhnika" were exercising control of rodents. Poisoned and bacterial baits were distributed by means of reequipped machine units OShU-50, OPS-30B and others; mineral fertilizer spreaders and seeders were also used; some part of the work was done manually.

Altogether during the fall and winter of 1977-78 and the spring of 1978 6.8 million ha were treated against mouselike rodents, which considerably exceeds the figures for many previous years. Harmful rodents were also brought under control in storehouses, greenhouses, hotbeds, clamps, stacks and ricks.

A large role was played by agrotechnical measures: plowing-up of early fall-plowed fields, reploting of road shoulders and virgin soil areas, removing of straw from the fields, etc.

According to the data of Adygeyskaya station for plant protection reploting of row spacing and annihilation of weeds in the orchards have decreased the population of mouselike rodents by 45-55 percent. Ammonia water was widely used for the treatment of stacks and ricks. The number of rodents decreased therewith by 95-99 percent (for example, in Belgorodskaya Oblast where 275,000 t of coarse fodder were treated in 1978).

One method of rodent control is the scattering of poisoned baits. Technological efficiency of the bait method usually amounts to 80-95 percent. Application of baits in 36,000 ha in Adygeyskaya Autonomous Oblast allowed for an additional 117,600 rubles worth of products and in 24,000 ha of winter wheat in Rostovskaya Oblast--147,000 rubles worth.

Application of bacterodencide in 13,500 ha of winter wheat in Severo-Osetinskaya ASSR yielded an additional 123,000 rubles worth and in 22,000 ha in Bashkirskaya ASSR--139,000 rubles worth. In some areas, however, surveys aimed at identifying rodents and protective measures were not conducted timely and the role of the agrotechnical technique was underestimated. The species and number of rodents were not always taken into account in identifying the methods and means of control; the quality of bacterial preparations was poorly checked which resulted in the decrease of the efficiency of protective measures. Untimely and inexpert control in some enterprises resulted in damaging the fields of perennial grass and fruit plantations; root crops preserved in hotbeds and clamps were damaged too. Fruit plantations in some areas of Moskovskaya and Bryanskaya Oblasts and of Bashkirskaya ASSR and perennial grass in Lipetskaya, Kaluzhskaya and Vladimirskaia Oblasts were considerably damaged.

In 1979 these vermin are also very dangerous, especially in the regions of the Northern Caucasus, the nonchernozem zone and the Volga area. Thorough



observations of the growth in the population of mouselike rodents should be conducted; it is necessary to exercise continuous control over the state of the population and to implement the whole system of recording and control. It is necessary to involve specialists from enterprises in conducting surveys more broadly, to organize brigades of inspectors for a complete and exact identification of areas populated by rodents and requiring treatment.

In the areas of overall propagation of rodents it is very useful to conduct reconnoitering circling flights in helicopters (particularly over the fields of winter crops) in early spring and fall. Centers of an increased population of rodents can be clearly seen, surveys will be completed quickly and the protection of fields can be organized in time.

Control of rodents must be systematic. Timely harvesting without losses, removal of straw from the field, fast and timely replowing of fields after harvesting, annihilation of weeds, clearing of forest strips and other measures are important. Efficient implementation of all agrotechnical techniques will allow for reducing the amount of treatment by various preparations and the total cost.

In springtime control must be first of all conducted in the centers of rodent infestation (fields of perennial grass, fallow lands, edges of forests and forest strips, shoulders of ditches and roads, hay ricks, straw stacks), in order to prevent propagation of rodents in the fields of winter crops. Preparatory treatment must be begun as early as possible, before thick green vegetation appears.

Efficient protection of the fields of agricultural crops depends to a great extent on the correct selection of means and methods of control in each specific case. In so doing it is necessary to take into consideration the species of rodents, their numbers and the current ecological situation. It should be remembered that field mice are barely susceptible to bactorodencide. With the utilization of chemical and biological means, technology and accident prevention should be strictly observed.

A successful solution to the problem of efficient control over mouselike rodents depends to a great degree on scientific institutions. It is necessary to accelerate the development of more perfect, effective methods of control, to increase the assortment of chemicals, to organize the manufacture and to accelerate the incorporation in production of ready-made granulated baits on the basis of zinc phosphide and other rodent poisons. In order to raise the quality and effectiveness of rodent control it is necessary to accelerate the production of special, highly efficient ground machines for bait spreading. New methodology for determining the yield loss caused by mouselike rodents will be helpful too. Measures for the increase of bactorodencide production and its quality must be taken.

Joint efforts of scientists and specialists from plant protection service and enterprises will help prevent overall propagation of mouselike rodents and reduce their harmfulness.

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## AEROSPACE MEDICINE

### HEALTH PROGNOSIS IN FLIGHT DISCUSSED

Moscow MEDITSINSKAYA GAZETA in Russian 30 May 1979 p 3

[Article by Professor R. Bayevskiy]

[Text] Long space flights require of a human organism not only the stability to extreme influences, but also flexibility of adapting to new conditions and active participation of adaptive mechanisms. This, in turn, leads to the de-adaptation of the organism in relation to the earth's conditions and makes the return to the earth's gravitation quite dangerous. Thus, it became necessary to develop a system of preventive measures which would ensure a rapid readaptation of the organism on the earth, as well as to develop a system of predicting the state of health of cosmonauts directed toward the revealing of their early or latent changes.

At the present time, there exist two viewpoints on the pathological deviations and diseases which are possible in the course of a flight. According to the first viewpoint, the same states and diseases will be observed in space as in the earth's conditions. The other viewpoint asserts that the unusual conditions and the weightlessness effect could cause quite unusual combinations of symptoms and syndromes. In this connection, there appeared two approaches to the prognosis: the first approach is oriented toward the possibility of appearance of concrete states and diseases in flight; the second approach is oriented toward revealing and evaluating the tendency toward the aggravation of the state of health. These approaches are analogous to the normative and research principle existing in the modern theory of prognostication.

Depending on the degree of the indefiniteness of probable events (states), it is possible to use clinicophysiological or heuristic methods of prognostication. Clinicophysiological methods make it possible to give a qualitative evaluation of the responses of the organism proceeding from the concepts of health and disease, of the norm and pathology, existing in medicine and physiology. Heuristic methods are based on the use of intuition and experience of highly skilled experts.

It was the heuristic methods that were used in space medicine initially, for example, during the flights of orbital stations "Salyut-1" and "Salyut-4",



because at that time the necessary information was not accumulated and there was no experience in predicting the state of human health under the conditions of space flights. At the present time, heuristic, or expert, prognostication has become generally recognized and continues to improve. Diseases and pathological states of various lengths which are probable in flight have been established with the aid of expert evaluations. During the flight, all information is periodically analyzed by a group of experts. Usually they use the normative approach, i.e., they give their opinions about the probability of the development of states and diseases they are well familiar with as clinicians or physiologists. Then these opinions are "processed" with the aid of electronic computers and a prognosis is formed which represents a generalized probable picture expected in the future.

Simultaneously with the heuristic methods, clinicophysiological methods of prognostication are also used. They are based on a thorough analysis of the objective data on the state of health of cosmonauts. For example, recordings of an electrocardiogram and the results of pulse rate and arterial pressure measurements are compared by specialists with known symptoms of diseases and pathological deviations. In this case, the research approach yields a considerably larger amount of information for prognostication. The state of the cosmonaut is viewed as the result of the adaptation of the organism to the flight conditions, and the degree of adaptation is the object of prognostication. It is the disturbance of adaptation, "breakdown" of the adaptation mechanism, that is the beginning of any disease.

The traditional clinicophysiological methods are not suitable for evaluating adaptation responses of the organism which lead to disturbances of homeostasis. Such indexes as the pulse rate, arterial pressure, stroke and minute volumes of blood circulation do not change substantially in the process of the adaptation to the conditions of weightlessness. Therefore, methods making it possible to determine the degree of strain of the regulation mechanisms and the functional reserve of physiological systems are being introduced into the practice of medical research in space. In other words, we are talking about the determination of the "price of adaptation". For this purpose, for example, functional tests are used with a dosed physical load and creation of negative pressure on the lower half of the body. Mathematical analysis of the cardiac rhythm is of great importance. On the basis of studying the regulation of the function of cardiac automatism, it makes it possible to obtain important information on the tonus of the sympathetic and parasympathetic parts of the vegetative nervous system and the functional state of the subcortical centers and the cerebral cortex. The energetics of the myocardium is studied with the use of the method of seismocardiography, and the first attempts were made to use ballistocardiography. The use of portable magnetic recorders for continuous round-the-clock recording of the electrocardiogram is important for understanding the peculiarities of the adaptation of the organism to the flight conditions.

The methods and principles of predicting the state of health of cosmonauts described above are used in the medical control system in the flight of the

orbital station "Salyut-6". All the information about the crew which is received by radio, television, and radiotelemetric channels is processed with the aid of electronic computers and is thoroughly analyzed by specialists. The state of cosmonauts' health depends considerably on the progress of the process of the adaptation of the organism to weightlessness conditions, and this process is individual. Special medical experiments are conducted regularly in order to study the states of the cardiovascular, neuromuscular, respiratory, and other systems of the organisms. Such factors as the length of sleep, the work routine, the diet, and degree of the psychoemotional stress are also of great importance. The creation of comfortable hygienic conditions within the orbital station and maintenance of the necessary levels of temperature, humidity, and pressure also contribute considerably to the condition of the cosmonauts.

The prognostication system is served by a large group of highly skilled consultants which includes leading scientists of the country. In fact, we should speak about a single consultative prognostication group which uses modern computers and mathematical methods in its work.

The experience accumulated in the course of the 96-day flight of cosmonauts Yu. V. Romanenko and G. M. Grechko was of great importance for predicting the state of health of cosmonauts V. V. Kovalenok and A. S. Ivanchenkov who spent 140 days in flight. Although the program of each subsequent flight contains new elements, the basic regularities of the adaptation to the flight conditions are preserved, and here the prognosis by the method of analogies is possible. However, the processes of adaptation progress very individually, and, therefore, with each new flight we deepen and expand our knowledge in the area of space medicine and accumulate practical experience of medical prognostication.

Prognostication of the state of health of cosmonauts during a long flight, as is the flight of the crew of the orbital station "Salyut-6", is a complex process of the collection, storage, and processing of varied information. Possibly, it is in such space experiments that the foundation is laid for the medicine of the future whose efforts will be directed not toward treating diseases, but toward preservation of health.

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THE THIRD SYSTEM OF REGULATION OF ANIMAL AND HUMAN FUNCTIONS, THE ACTIVE POINT SYSTEM

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[Text] In spite of the substantial advances made in the study of mechanisms of control of vital functions of organisms, there are several phenomena observed in this area that cannot be interpreted from the standpoint of function of nervous and humoral systems. For this reason, it is expedient to try to draw on data on the system of "active points," which are used in oriental medicine in the treatment of many diseases, to analyze these phenomena.

Summary data are submitted on "active points," "meridians" and interaction thereof.

Conceptions are expounded of the "system of active points" as the third autonomous system of regulation of the human and animal body, on the basis of theoretical analysis of data in the literature. This system transmits information about changes in the environment and in the body, regulation of functional state of meridians and related organs, and coordination of their activity. Thus, its function is adaptive in nature.

A hypothesis is expounded on the electromagnetic nature of transmission of influences in the active point system. Problems that should be worked on are listed.

Research dealing with identification of the mechanisms and structures of control of vital functions of organisms occupies a leading place in biology. The enormous diversity of changes in the environment, in which organisms function, as well as the hierarchically structured organization of the latter, including a large number of levels, predetermines the complexity of

these structures. At the present time, the structure and function of the nervous and hormonal systems have been described rather well.

Most investigations deal with the nervous system, which is methodologically attributable to the ease of demonstrating its reactions and speed of their occurrence. Problems of autonomic nervous system function have been worked on considerably less; as stated in the "Great Medical Encyclopedia," the autonomic nervous system is "a part of the nervous system that regulates the functions of the viscera, glands, blood and lymph vessels, smooth and, in part, striated, muscles" [Vol 6, 1976, p 60]. Many investigations pursued in this field are related to demonstration of correlations, which are reflected in clinical symptoms and syndromes, reflex zones of innervation of internal organs on the body surface, etc.

There is an extensive literature on humoral regulation, which takes place through the liquid media of the body, by means of biologically active substances secreted by cells and organs. It was demonstrated that there is a close link between the humoral and nervous system (for example, by Ashiba, 1976).

However, in spite of the substantial advances made in the study of mechanisms of control of vital functions of organisms by means of the nervous and humoral systems, many of the phenomena observed in this area, which are discussed in a special section of this article, have not yet been explained. At the same time, a system of "active points" in man was described in ancient oriental medicine, and many diseases are treated by exercising an effect on this system. At the present time, we know of a maximum number of correlations between some control circuits and functional activity of organs.

For this reason, it is deemed promising to pursue comprehensive investigations in expressly this direction, since there is here a very large amount of primary information, which could be the basis for rather comprehensive experimental verification and for identification of the mechanisms of regulations that occur.

#### Main Information About "Active Points"

In ancient Chinese medicine, conceptions were expounded on the presence on the surface of the human body of points, treatment of which normalizes vital functions. There are about 700 such points in man, on the head, trunk and extremities (Zhu Lian, 1959). In addition, there are several regions where a small area is occupied by groups of points bearing information about the state of all vital organs (they are called the "windows of the body"). This refers to the conchae of the ears, for each of which about 140 points have been described (Tabeyeva, Klímenko, 1976) and the nasal meatus with thirty points in each (Vogralik, 1961); equally informative zones are known to be located on the foot and tongue [Chen, 1969]. Thus, there are more than 1000 points in all that have been described and are used to treat man.



The above points have been used extensively from ancient times to our days in medicine and veterinary practice to normalize functional activity of man and animals (Vogralik, 1961; Plakhotin, 1966), as well as to change the body from an active to a passive state, anesthesia, karate, etc. (Mann, 1973; Manaka, Urquhart, 1975).

In a number of cases, the location of these points coincides with the endings and branches of nerves, and in others, to branches or plexi of the blood and lymph systems and other anatomical distinctions. However, there is no unequivocal link of the points to the nervous system (Vogralik, 1961).

In the 1950's, electrical instruments began to be used to study these points; they revealed that there is a site of increased conduction of electricity by the skin surface in the points described 5000 years ago (Podshibyakin, 1959; Vogralik, 1961; Mann, 1973; Chan, 1974; Reichmanis et al., 1976). Increased biochemical metabolism and heightened sensibility to temperature were also demonstrated in the same points (Vogralik, 1961). If the function of a point is impaired, there is a change in its resistance to electricity, temperature and pain, as compared to normal; occasionally, consolidation of tissues is palpable in the region of the points, and it disappears after special treatment. There is also normalization of electrical resistance and other parameters. The points of increased activity are called "active points" by a number of authors (for example, Usova, Morokhov, 1974). Hereafter, we shall use this term.

Analogous active points have been found in a number of mammals and birds: the horse, cow, pig, rooster, rat and Indian elephant. They are used on farm animals, for treatment and to increase productivity (Plakhotin, 1966; Mann, 1973).

Thus, current data confirm the existence of special properties on the skin surface, in the active points indicated in ancient sources.

#### The "Meridians" as Functional Systems

According to data in the literature (Goux, 1955; Vogralik, 1961; Mann, 1973), the active points are connected through 14 "channels" or "meridians," 12 of which are paired, 6 on each hand and leg, and 2 are on the anterior and posterior midlines of the body surface. Ten of the meridians are related to the vital organs--lungs, heart, liver, etc., and four are control meridians: anterior and posterior median, meridians of the three parts of the body and pericardium. The same active point may be related [linked] to several organs and, conversely, each organ or a specific function usually depends on the influence of several points that are situated both on the same and different meridians.

Of all the points, which number from 9 to 67 on different meridians, a distinction is made of the most important ones: "tonic," "sedative,"

"stabilizing," "assistants [accomplices]" and "messengers [heralds]." Some active points ("sympathizing") are on other meridians (Mann, 1973).

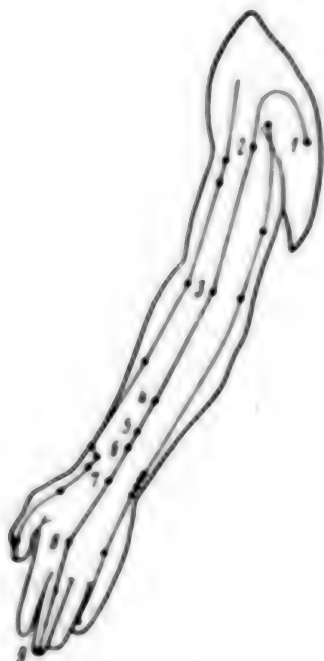


Figure 1.

Diagram of meridians situated on the internal aspect of the arm: meridians of the lungs on the left, of the pericardium in the middle and heart on the right. The following points are on the pericardial meridian (in the middle):

- 1) messenger
- 6) stabilizing
- 7) sedative and assistant
- 9) tonic ("An Outline of Chinese Acupuncture")

1961). Thus, the concept of "meridian" refers to a certain functional system; it is comprised of an aggregate of active points of a given meridian, their links with one another and regulated organs, as well as other meridians.

The meridians are divided into two groups. One of them, called the "yan," refers to meridians in which energy is produced, the meridians of the stomach, small and large intestine, gallbladder and bladder and the meridian of the three parts of the trunk that regulates their activity. The other, which is called the "yin," consists of meridians in which energy is stored and used: meridians of the heart, lungs, liver, spleen and pancreas, kidneys and

It is believed that the tonic points have such an influence on the entire meridian and on all organs linked to it. The sedative points have a calming action; the stabilizing ones fix the state of the meridian after a tonic or sedative action. The assistant points are additional ones, and they enhance the regulatory effects of other main points. The messenger points are distinctive indicators; one can assess the functional state of an entire meridian on the basis of their state. Pain is often experienced when these points are depressed (or even without so doing), which is indicative of functional impairment of this meridian. The sympathizing point makes it possible to affect the state of a given meridian from another meridian (Vogralik, 1961, "An Outline of Chinese Acupuncture," 1975).

It is easy to check experimentally for the presence of correlations between different active points. Some points, in which conduction is diminished, can be very rapidly returned to their normal level by treating other points.

It should be noted that the concept of an organ regulated by points of the corresponding meridian is an integrative one. Thus, the meridian of the lungs regulates the function of the entire respiratory system, including the nasopharynx and respiratory tract; the meridian of the kidneys regulates the uropoietic, excretory organs and a number of endocrine glands (Vogralik,



the pericardial meridian that regulates their function. The two unpaired meridians, anterior and posterior midlines, implement regulation on the level of the organism, coordinating the function of the yin and yin systems (Mann, 1973).

Figure 1 illustrates the pericardial meridian, which is also called the vascular-sexual one. The points on this meridian influence regulation of five energy-consuming yin meridians, and they also have a regulatory effect on the vascular system (they lower elevated arterial pressure, remove pain in the cardiac region and tachycardia), higher nervous activity (they normalize the condition in the presence of neurosis and certain mental disorders), etc. (Vogralik, 1961; Mann, 1973; Usova, Morokhov, 1974).

#### Interaction Between Functional Systems

The teaching on interaction of meridians (Vogralik, 1961; Mann, 1973, and others) in accordance with the links expressed by the ancient oriental pentagon (Figure 2) is very interesting. It indicates the directions of tonic and sedative effects of some meridians on others. The important distinction of the effect is that each functional system (meridian) has the strongest influence on its related systems at a very specific time of day.

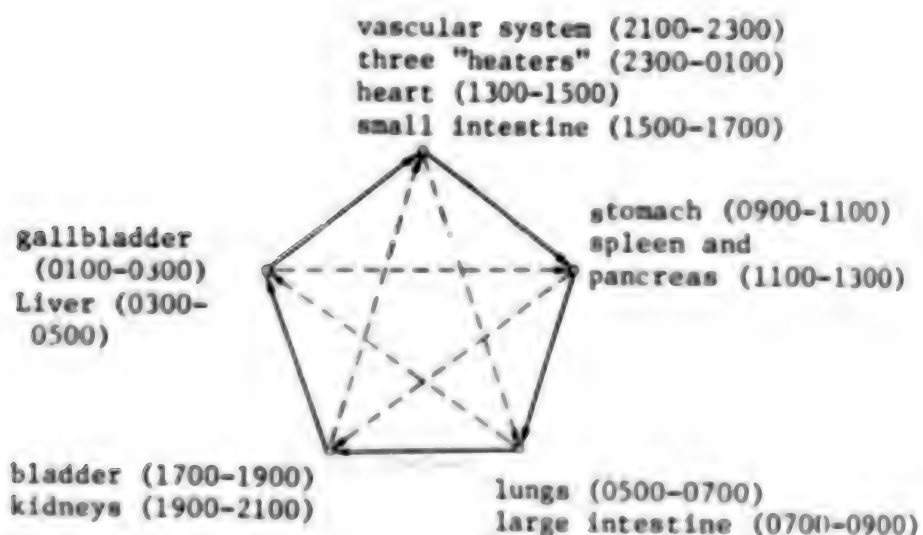


Figure 2. Ancient oriental diagram of interaction of organs and systems. The solid lines refer to the direction of tonic effects, and the dash lines, to sedative effects. The time of maximum tonic activity of organs is indicated in parentheses (hours). The time of maximum sedative activity is 2 h earlier (Vogralik, 1961; Mann, 1973)

Thus, the lung meridian has a maximum sedative effect on the meridians of the liver and gallbladder from 0300 to 0500 hours and a tonic effect on the meridians of the bladder and kidneys from 0500 to 0700 hours. The meridian of the large intestine has the same influences, but 2 h later. If the lungs and the respiratory tract are in a good functional state, the influences relayed from the lung meridian are also normalizing. Otherwise, these influences disrupt the function of the organs to which they are delivered. Hence, the state of a functional system depends largely on the aggregate of influences of other systems on it, for example, pain in the cardiac region may be caused by diseases of the liver or gallbladder and kidneys or bladder, rather than cardiac pathology.

At the present time, an active search is in progress of the links between organs and systems of the body during development of diseases. The links that are illustrated in the pentagon are being confirmed. Thus, according to the data of the Institute of First Aid imeni Sklifosovskiy, acute ulcers, erosions and other changes in the gastrointestinal tract were demonstrated in 60% of the autopsies made on patients who had died of heart and cardiovascular lesions (Markova, 1976), and this is consistent with the diagram in Figure 2, in which the meridian of the heart has a tonic effect on the meridian of the stomach and a sedative effect on the meridian of the large intestine. Changes in the digestive tract, particularly the stomach, not only accompany angina pectoris and myocardial infarction, but occasionally obscure the signs of the chief complaint (Markova, 1976).

Many of the links illustrated in the pentagon have been demonstrated and used extensively in clinical practice by S. P. Botkin (1883-1888): effect of the gallbladder and liver on the small intestine and stomach, effect of the reproductive system on thermoregulation, effect of the heart on the lungs, effect of the spleen on the reproductive system, and by G. A. Zakhar'in (1910) effect of the liver on circulation, effect of the kidneys on the heart, and other associations.

A comparison of the time of circadian activity of different organs, according to data in the literature, to the time of activity of meridians (see Figure 2) shows that they are in agreement. For example, angina pectoris, hypertension, cerebrovascular thrombosis and accidents, infarction, are most often encountered between 0100 and 0500 hours (Agadzhanian, 1975), which corresponds to the time of activity of the gallbladder and liver, that have a tonic effect on the heart and the vascular-sexual system.

In addition, morphological and functional changes occur in the course of individual development of any organism, at specific periods. During such "transitory" periods, some organs lose weight (Avtandilov, 1973). At this time, even minor influences may be sufficient for the onset of serious diseases.

Thus, one must take into consideration the existence of circadian and other rhythms of body activity, and one should determine not only the place, but the most suitable time of treatment for successful restoration or stimulation

of body functions. (This applies not only to treatment via the system of points, but to any other means of therapy).

#### Exogenous Influences on the System of Active Points

The condition of the meridians as functional systems depends appreciably on the effects of exogenous factors. There are several studies dealing with the influence of lunar rhythms on function of organisms. We know of several rhythms in man with a cycle of about a month (Swoboda, 1904; Fliess, 1909; Perna, 1925; Thommen, 1976). Manaka and Urquhart (1975) discuss the influence of phases of the moon on possibility of regulation of body functions from specific points.

There are even more works dealing with the effects of solar activity on the biosphere (for example, Chizhevskiy, 1930, 1976; "Influence of Solar Activity on the Atmosphere and Biosphere," 1971; "The Sun, Electricity and Life," 1972; Dubrov, 1974; Kaznacheyev, 1977). Points and months of the most effective treatment are mentioned in old Chinese sources, as related to the year in the Chinese 60-year solar-lunar calendar (Yang Ji-zhou, 1601). Zai (Tsai, 1974) discusses the problem of determining the time and place of acupuncture coordinated with exogenous rhythms and rhythms of the body, at which the single use of one point is sufficient for normalization of functional activity. In addition to lunar and solar rhythms, there may also be other exogenous ones, both astrophysical and terrestrial, which could influence vital functions and, in particular, the condition of active points (Mann, 1968).

Terrestrial factors--local fluctuations of temperature, pressure, humidity, etc.--are taken into consideration in the treatment and prevention of diseases. However, the results of these investigations are virtually unused in the practice of regulating human and animal functions, including the use of the system of active points. At the same time, numerous observations indicate that the same treatment may have a different effect, depending on the time it is administered. This is related to the above-mentioned cyclic nature of maximum activity of different meridians, as well as the many other endogenous and exogenous rhythms that must be taken into consideration when artificially regulating the functional state of the body.

#### Variants of Methods of Treating the Body Through the System of Active Points

The methods of using the active points are very diverse. As reported by Mann (1973), people of the Bantu tribe in South Africa scratch specific points on their body to cure a disease. Arabs cauterize part of the ear with a hot metal rod to treat radiculitis. Eskimos use a sharp stone for acupuncture. In some tribes of Brazil, tiny arrows are pierced through a tube into specific parts of the body surface.

Acupuncture, heating the points with wormwood cigarettes, use of plasters, ointments, fomentations, injections of certain substances at the sites of

the points and acupressure (applying pressure with the fingers, patting and tapping the points) are practiced widely. Use of electric stimulation led to a new method of treating the body through the points of high conduction, i.e., electropuncture (Chan, 1974). Although the optimum levels of the main parameters of treatment have not yet been defined, they are considerably lower than in physiotherapy.

Electropuncture has some advantages over acupuncture. Before administering acupuncture therapy one must diagnose the disease. For this purpose, in oriental medical practice, one examines the pulse thoroughly at several points on both arms. This method permits rather accurate identification of the involved regions of the body, but it is very complicated [or difficult], so that it cannot be readily learned (Violin, 1903; Vyaz'menskiy, 1955).

Further, one must know which points, what needles, to what depth and for how long one should administer treatment, as well as the exact location of the points, so as to hit them with needles. Thus, acupuncture requires special training and long practice.

The use of electropuncture makes it possible to find an active point rapidly and to assess its functional state according to the readings of electric measuring instruments. A normal state of an active point is characterized by a rather stable current intensity in the system at a preset voltage, i.e., resistance to the exogenous electric circuit. When the direction of the current is reversed, there should not be any appreciable change in level thereof.

Decrease and increase in current intensity, as well as absence of symmetry when it is reversed, are indicative of functional impairment of the point. Measurement of the current in several main active points on the limbs makes it possible to detect the meridians related to the organs with functional impairment and thus to determine the source of disease.

Electropuncture therapy is also simpler. First of all, if an active point shows normal electrical readings, one usually does not treat it. In the presence of decreased or increased conduction, electric treatment is delivered to the point in order to normalize its condition. Finally, unlike needles, the active electrode does not puncture the skin, but merely applies pressure to it.

The combination of acupuncture with electrotherapy led to appearance of another direction of treatment, electroacupuncture (Duke, 1974). At the present time, studies are also in progress of the effects of laser beams on active points (Inyushin, Chekurov, 1975), as well as of ultrasound (Gavrilov et al., 1976) and magnetic fields. The use of the latest technological advances combined with ancient methods of treatment could lead to development of new and rather effective means of controlling vital function processes.

At the same time, acupressure is gaining increasing use; this is a method of therapeutic and preventive treatment by means of massaging certain active points: applying pressure with the fingers, rubbing and other manipulations. The acupressure method is simple to use and quite effective, for which reason it is very popular in China, Japan, India, Mongolia, FRG, the United States and other countries (Bergson, Tuchak, 1976; Namikoshi, 1976; Ulrich, 1976).

#### Functions of Systems of Active Points

Thus, we are dealing with a system of regulation of the functional state via active points, which has been described quite comprehensively. Sampling testing of its capability, as well as a comparison of the basic tenets to data in modern biology and medicine, demonstrate that it is of interest.

No verification had been made of the function of the system of active points as a whole. However, the 1000-year history thereof and the enormous number of people using the properties and capabilities of this system to regulate functional activity show that we are dealing here with a reasonable base, which is a problem for research with the use of modern scientific methods.

Apparently, the functions of the active point system consist of carrying information from the peripheral parts of the body, which are related to the exogenous environment, into the body, as well as from some internal organs to others and to the periphery. It implements reciprocal "adjustment" [tuning] of different parts of the body and regulation of their functional state.

Thus, the system of active points is one of the control systems related to adaptation of the body to changing environmental and endogenous conditions. Along with the nervous and humoral systems, the system of active points implements the function of the body as a whole.

The data submitted here concerning the function of the system of active points lead us again to the conclusion that the human body is an extremely complex, self-regulating system consisting of a number of interrelated hierarchically subordinated systems of different orders, united by various mutually supplementary mechanisms of regulation.

The attention of I. P. Pavlov was specially drawn to the problem of integrity of the body, as an aggregate of interrelated functional systems with integrative mechanisms of regulation. He wrote: "Man is, of course, a system ... that is highly self-regulating, self-supporting, restoring, guiding and even refining [improving]" (Pavlov, 1923).

As we see, the function of the system of active points enlarges our conceptions of mechanisms of integration and adaptation of the body as a whole.



## Autonomy of the System of Active Points

Some physicians try to attribute the beneficial results of acupuncture and electropuncture to psychotherapy, i.e., suggestion phenomena. It is impossible to deny the psychotherapeutic effect of acupuncture, as is the case with any other form of therapy.

The fact that there is a somatic response to treatment of the system of points, i.e., a direct effect on the body, has been confirmed by the successful acupuncture treatment of farm animals (Plakhotin, 1966), which do not have a second signaling system, through which suggestion is implemented in man.

Another proof is the specificity of effects of stimulation of active points in different meridians in man: heart attacks can be removed by applying an electrode to some points, while stimulation of others is needed to eliminate respiratory disturbances or other functional disorders. The psychotherapeutic effect, however, is nonspecific, i.e., the same suggestions may attenuate or remove pain of diverse origin.

As mentioned above, there are many facts related to regulation of functional state that are difficult to attribute to the function of the nervous and humoral systems. This had already been observed in the last century by the neuropathologist, Charcot (1876), who wrote that "the most complex processes of nutrition take place in some organisms without the intervention of the nervous system.... In embryos, there are also processes of organic life at the stage of individual development when they have none of the elements of the nervous system." Charcot further observes that "certain tissues, even in higher animals, are completely wanting in nerves and vessels" (p 4). "... Peripheral regions, for example muscles and bones of the limbs, continue to live and take nourishment almost as they would under normal conditions and integrity, even after severing nerves going to these organs and even after impairment of the spinal cord.... Atrophy does not occur at all if, after total severing of the sciatic nerve, galvanic current is passed daily through the muscles of the paralyzed limb" (p 5).

There are the following groups of phenomena related to treatment via the active points, which cannot be interpreted from the standpoint of neuro-reflex theory, without expounding hypotheses on the existence of receptors and nerves, in addition to those that have been described and unknown to science, as well as reflex arcs that have not yet been discovered.

We refer, first of all, to the above-mentioned influences of some meridian points on others. The possibility of such influences shows that certain groups of points are interrelated, i.e., they have some means of conveying signals. At the same time, special investigations revealed that there is no unequivocal link between the active points and the nervous system. Such links have been demonstrated for 120 points, and for this reason the others are considered "unwarranted" for acupuncture, whereas there has



been repeated experimental confirmation of the effectiveness of treating them (Vogralik, 1961; Mann, 1973).

In the second place, remote points that are very far from an organ with impaired function are used for the most part in administering acupuncture therapy. Such remote points often have no established link with the nervous system.

In neuropathology, so-called repercussion or reflected phenomena have been described (Thomas, 1929; Krol', 1935; Markov, 1936; Uflyand, 1950, and others), when changes are noted in remote, anatomically unrelated parts of the body as a result of injury to one organ. One of the present authors (Zhirmunskiy, 1954) has demonstrated that there are reliable changes in binding of vital stains in the cornea of rats (assymetrical for different eyes) after severing the sciatic nerve and, according to D. N. Nasonov (1959), this is indicative of changes in functional state of the cells. In view of the fact that effector innervation of the cornea has not been established, the assumption was voiced that a humoral mechanism was involved in the noted changes. However, it could also be assumed that these changes are related to influences via active points.

In the third place, the effects of some functional systems and corresponding organs on others, according to the pentagon of links between meridians (see Figure 2) which we mentioned above, can also not be substantiated as reflexes.

In the fourth place, the influences via the system of points are the most effective at very specific times of day, whereas such a clearcut periodicity has not been demonstrated for reflexes.

In the fifth place, the system of active points is characterized by the capacity to normalize a function by treating different, though specific, points. In the nervous system, the main reaction is substituted only in the presence of pathology, as a result of compensatory processes.

The effect obtained through the active points cannot be attributed to humoral regulation either, first of all, because of the considerably faster transmission of influences through active points than is known for humoral reactions. The asymmetry of functional state in the rat cornea after severing one of the sciatic nerves, observed in the above-mentioned study (Zhirmunskiy, 1954), also cannot be attributed to humoral mechanisms.

The foregoing warrants the belief that the influences relayed by the system of active points are basically different from those in the nervous and humoral systems. This enables us to expound the hypothesis that there is an autonomous third regulating system in the body of man and other animals, about which there is no information as yet in textbooks of physiology and medicine.

The autonomy of the third system of regulation ensues from the foregoing. At the same time, the system of active points interacts with the nervous and humoral systems. In several cases, the active points coincide with the sites of exit and branching of nerves (Vogralik, 1961). There are many receptors of treatment through the points that provide for stabilization, not only of the nervous system but mental status. Moreover, nervous disorders are diagnosed according to the state of certain active points (Goux, 1955).

Correlations with the endocrine system are demonstrated by the possibility of diagnosing endocrine disorders through the active points, as well as of controlling the state of the endocrine system through these points (Goux, 1955; Tabeyeva, Klímenko, 1976).

Thus, we are dealing with an autonomous regulatory system that is interrelated with the nervous and humoral systems.

More recently, the American surgeon, Becker (1974, and others) has been developing the conceptions of existence of an autonomous system in man and animals for "transmission of data and control" of different functions, that is related to the acupuncture points, on the basis of his research on constant potentials in different parts of the body and effect of electric and magnetic fields on processes of regeneration and growth.

#### Hypotheses on Mechanisms of Function of the System of Active Points

The links between different parts of the skin surface and viscera at a substantial distance from these points had already been investigated by the physicians G. A. Zakhar'in (1910) and Head (1919), leading to development of sectional massage that gained wide popularity in medicine (Glezer, Dalikho, 1965).

What then are the mechanisms of regulation of functional state of the body through the active points? There is no agreement on this score. Different authors expound different theories: electrical, capillary, humoral, reflex, etc. (see, for example, Vyaz'menskiy, 1961; Usova, Morokhov, 1974).

At this time, our information concerning the structure of the system of active points is rather incomplete. Few studies have been made of their histology. Kim Bon Hang (1964) described "channels" investing the surfaces of blood, lymphatic and nervous systems and all viscera. However, these data were not corroborated, and there must be further verification thereof.

Several authors, for example, V. F. Mashanskiy et al. (1977), considered the possibility of nerve-free transmission of information through intercellular fissure contacts in the human epithelium. The authors also cite their data on the existence of such slit contacts in the coenosarc that connects polyps in a colony of corals, in which no nerve elements could be demonstrated. They assume that the slit contacts correspond to the directions of the acupuncture meridians. This hypothesis is of substantial interest; however, it

requires thorough verification, as well as development of the problem of how "nerve-free transmission" from one tissue to another takes place. Thus, for the time being, there is no reliable information about the morphology of the meridians.

Perhaps, influences are disseminated in the system of active points by means of electromagnetic fields. In view of the fact that, at the present time, not only electromagnetic fields, but rather weak constant magnetic fields, the intensity of which occasionally changes by factors of 10 with changes in functional activity of the body, according to the data of American scientists (Cohen, 1975), the hypothesis can be expounded that the active points may represent two or more, rather than one, basically different regulatory systems, with respect to their mechanisms of transmission of energy and information.

It may be that there are both regulation of overall level of energy status of the body and fine synchronization of functional activity of different organs and systems. From this point of view, the mechanisms of regulation of the overall level may be related to fluctuations of constant electric and magnetic fields, whereas fine regulation may be related to high-frequency factors. At the present time, the latter are used, in particular, for electroanalgesia in obstetrics and surgery (see, for example, "Theoretical and Clinical Aspects of Electrosleep and Electroanesthesia," 1976).

#### Problems and Prospects

Thus, we have described a system of active points as an integral mechanism of regulation of vital functions. The conceptions about this system take into consideration correlations between the main functional systems of the body, classification thereof into "producers" and "consumers" of energy, time-related organization of the function of meridians and dependence on the state of the environment of the function of active points.

Verification of the validity of this system is a very difficult task, even with the use of the armamentarium of modern investigative methods. Without conducting special comprehensive research, we can only discuss the random [sampling] verification of these results.

In view of the foregoing, the following basic theoretical and experimental problems are raised:

1. To identify the structure, functional significance and patterns of function of the system of active points.
2. To investigate the morphofunctional structures of the main carriers of information and parameters thereof for the system of active points. To define the hierarchic order of active points and systems thereof.
3. To demonstrate the mechanisms of transmission of influences in the point--meridian--lesion system.

4. To investigate the nature of interaction between corporeal active points and "windows of the body" (eyes, ears, nasal meatus).
5. To investigate the correlation between the system of active points and the nervous and humoral systems.
6. To investigate the interaction between environmental rhythms and rhythms of functional activity of the system of active points.
7. To construct models of functional activity of the body, which take into consideration the correlations between its main organs and systems.

These investigations require integrative interpretation of the results, and this could gain understanding of the principles of function of this system, as well as its role in regulating the function of the body as a whole.

At the same time, such investigations will make it possible to regulate the function of the body by means of relatively mild factors, which are capable of eliciting a rather significant and beneficial effect at a certain time. Such "regulation" will make it possible not only to treat the impaired organism, but to preserve the health of man and animals, as well as to raise their physical capabilities to a maximum, when there is a special need to do so.

In conclusion, the authors consider it their pleasant duty to express their sincere appreciation to E. A. Asratyan, N. P. Bekhtereva, V. Ye. Vas'kovskiy, A. A. Lev and V. N. Chernigovskiy for their attentive and critical examination of the contents of this article.

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TWO IMPORTANT DIRECTIONS OF DEVELOPMENT OF SOVIET BIOMETRY

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[Article by V. M. Shmidt, Department of Botany, Leningrad State University, submitted 20 Mar 78]

[Text] The author discusses the substance and area of application of the method of correlation clusters ["pleiads"] of P. V. Terent'yev and method of taxonomic analysis of Ye. S. Smirnov, which lead him to the conclusion that two important directions were formed on the basis thereof in Soviet biometry, and they play a significant role in development of different branches of biological science.

The history of development of Soviet biometry involves several directions and schools. We shall concentrate on the two of them, that are the closest to us scientifically and linked with the names of the late Pavel Viktorovich Terent'yev and Yevgeniy Sergeyevich Smirnov.

Both scientists were primarily outstanding biologists; P. V. Terent'yev was a recognized authority in the field of batrachology and herpetology, while Ye. S. Smirnov was a well-known entomologist. At the same time, they were outstanding biometricians, and their activities were directed toward adoption of mathematical investigative methods in biology. Their numerous disciples and proponents are successfully continuing the work they began.

The scientific heritage of P. V. Terent'yev and Ye. S. Smirnov is large and multifaceted. We shall refer only to the part thereof that is directly linked with the methods of correlation clusters and taxonomic analysis that they created; these are methods that originated two important directions of development of biometry, as we shall show in the following.

Both directions date back to the early 1920's. In 1923 and 1924, two articles by Ye. S. Smirnov were published, one of which was entitled "On the Structure of Systematic Categories" and the other, "Analysis of Distribution and Correlation of Signs in Systematic Categories." The titles of these articles clearly define the problem, which subsequently became one of

the leading ones in the scientific creativity of their author. The contents of these articles are remarkable in two respects.

In the first place, these works confirm the precedence of our biometry in the development of methods of so-called precise systematics,\* a direction that was subsequently given other names abroad: "taxonometry" (Rogers, Tanimoto, 1960), "taxometry" and "taximetry" (Hills, 1962; Barrett et al., 1969) and, finally, "numerical taxonomy" (Sneath, Sokal, 1962; Sokal, Sneath, 1963, and others).

In the second place, attention was first called in the above articles to the fact that the features [tags] of the body are not correlated chaotically, but form collections or groups, which Ye. S. Smirnov called "congregations." Within each such group, one can single out an "indicator sign" or "radical" that is the most related to other signs in its group.

Unaware of the works of Ye. S. Smirnov, Terent'yev arrived to analogous views. In 1931, his article was published in the journal *BIOMETRIKA*, with the first description of the method of correlation clusters [pleiads] on the example of the morphological features of *Rana ridibunda* Pall. The term, "correlation pleiads," which corresponds to the "congregations" of Ye. S. Smirnov, has gained a firm foothold in Soviet literature.

The scientific creativity of P. V. Terent'yev and Ye. S. Smirnov developed along different and original routes. As scientists, they had in common the desire to find new, precise methods of studying complex biological patterns. In particular, their attention was drawn to questions of analysis of the structure of links between features [signs] of organisms and taxons. Expressly this circumstance gave impetus to their development of the above-mentioned methods.

Our objective is to shed light, without going into the techniques of these methods that are familiar to a rather wide circle of biologists, on their substance and distinctions, and to demonstrate their significance and potential in the development of different branches of biology.

#### Correlation Pleiads

Calculation of all possible paired coefficients of correlation between tags of the object under study, i.e., presence of a correlation matrix, is the first prerequisite for demonstration of correlation pleiads. The first variant of the method (Terentjev, 1931) consisted of plotting a curve of distribution of absolute values of coefficients of correlations, which was usually found to have two peaks. Its left part (mild correlations) was considered the interpleiad part and the right (marked correlations, the

\*The term, "precise systematics," used by Ye. S. Smirnov is not well-chosen in our opinion, since one cannot divide systematics into "precise" and "unprecise." Systematics is integral and is called upon to be a precise science by its substances. For this reason, it would be more correct to refer to precise methods in systematics.



intrapleiad. The procedure of partial (special) correlation was used for demonstration of correlations in a "pure" form.

Subsequently (Terent'yev, 1959, 1960), this method was replaced by simpler and more graphic construction of a "mental correlation cylinder," through which one can make a "cross section" at any arbitrarily chosen level of correlation, and obtain a "correlation ring," with correlations applied within it in the form of lines. After some skill is acquired, the correlation ring does not necessarily have to be outlined, and one can directly sketch the correlation pleiads on a plane.

Isolation of correlation pleiads by this method was somewhat subjective: the level of correlation was selected arbitrarily, and one had to make a series of "mental sections" in order to find the level, on which the pleiads are actually manifested.

S. R. Vel'dre (1964), a disciple of P. V. Terent'yev, refined the technique, linking the algorithm of "maximum correlation route" (Vykhandu, 1964) with the idea of the method of correlation pleiads. With this method, at first a dendrite is constructed, which connects the correlation signs to a maximum, then by elevating the level of correlation this dendrite is submitted to successive "destruction." As a result of such an operation, the "shells" of the correlation pleiads are exposed, which can be readily adjusted to complete pleiads, and the latter are isolated on expressly the level of correlation on which they actually exist.

P. V. Terent'yev (1960) developed the fundamentals of the system of indices characterizing correlation pleiads quantitatively and qualitatively, which permit comparison of organisms or taxons according to these signs. They include composition, strength, sturdiness, geometric structure of correlation pleiads, level of correlation on which they are demonstrable, coefficient of homogeneity and indicator sign, which may be logical or statistical.

The phenomenon of biological correlations and the fact that correlation pleiads exist constitute a universal pattern of living nature. The teaching on correlation pleiads should become an important element of general theory of correlation structure of organisms and taxons. Strictly speaking, the term "correlation structure" should refer to the entire system of correlations between the signs of the object under study. In practice, we are always dealing with only a part of this system, and the term can be used only with due consideration of this stipulation. Theory of correlation structure of signs of biological objects is at the early stage of its development; however, even now, it is possible to study and compare this structure biometrically. Calculation of the "coefficient of divergence of correlations" (CDC), which we proposed (Shmidt, 1963) was among the first such attempts; subsequently, it was also used by other authors (Rukhadze, 1968; Aristarkhova, Ivanyukovich, 1976; Ivanyukovich, Hammer, 1976).

The importance of the method of correlation pleiads soon passed beyond the boundaries of systematics, and it is presently in wide use in various

branches of biology and medicine. The number of studies involving the use of the method of correlation pleiads is so large that it would be impossible to comment on them in a single article. We shall limit ourselves to mentioning some of them, which demonstrated that the method of P. V. Terent'yev has become a recognized research tool and thereby has changed into a special direction of investigation of the correlation structure of biological objects.

An ecological interpretation of the phenomenon of correlation pleiads in plants was offered in the works of R. L. Berg (1959, 1964 and others), as related to the stabilizing selection of flower and fruit characters; he also provided the first classification of types of correlation pleiads as related to the level of organization of living matter.

There is the very important question of changes in the course of evolution of correlations and, consequently, the question of dynamics of correlation pleiads in the course of ecological or geographic differentiation of the species. On the example of animals and plants, several works have shown that there is partial reorganization of correlation structure in the course of selection, with the formation of ecological or geographic races (Berg, 1959, 1964; Shmidt, 1963, 1964, 1969; Miklukho-Maklay, 1963; Kolosova, 1971, 1973; Popov, 1973, and others). We analyzed this process (Shmidt, 1963) on the example of transformation of correlation pleiads of morphological characters of *Odontites serotina* Dum., in connection with occurrence of ecological forms of this species with submersion of substrate and with invasion thereof as weeds in grain crop fields. The fact that a change in correlation structure of organisms in the course of evolution can occur in only small "doses," which do not cause its disintegration, has been specially stressed in the book by K. M. Zavadskiy and E. I. Kolchinskiy (1977).

O. L. Rossolimo and I. Ya. Pavlinov (1976, 1977a, b), who investigated the geographic variability of correlations between skull features of several rodent species, arrived at a conclusion, which is wrong in our opinion, that correlation coefficients and pleiads cannot serve as reliable enough indicators from the standpoint of systematics. Their conclusion is based, in particular, on the fact that the composition and structure of "correlation rings" within the ranges of some species vary markedly and indeterminately, and that the difference between adjacent populations is often greater than between those that are far from one another.

But we cannot reject the conviction of biometricians, which is based on many years of diversified experience, that correlations are less variable as a whole than the features themselves, on the basis of studying only the cranio-logical features of several rodent species. Moreover, in this case, the "correlation rings" are not consistent with correlation pleiads: each of them was formed by plotting all reliable relations, among which there were also some relatively weak ones. In this instance, the "correlation ring" is nothing more than a "general pleiad" on the level of reliable correlation and, of course, variability thereof is much higher than the variability of pleiads isolated on higher levels of correlation. Finally, with reference to

geographic variability of characters and correlations, the authors leave open the question of the share of ecological variability which, as we well know, may exceed geographic variability. Nor do they explain some statements, for example, that the higher the variability of characters the lower the variability of correlations between them and the higher the strength of the "correlation ring."

On the whole, the impression is gained that Rossolimo and Pavlinov exaggerate the degree and significance of geographic variability of correlation pleiads in their interesting works.

The method of correlation pleiads can aid appreciably in solving a number of phylogenetic problems. This was specially stressed by A. L. Takhtadzhyan (1966), in relation to the question of probability of parallel occurrence of taxons in the course of phylogenesis of flower-bearing plants. The fact of the matter is that the indicator signs of correlation pleiads are virtually independent of one another, and for this reason have the greatest taxonomic significance. A set of several indicator signs characterizes the taxon qualitatively, singling it out from the others. It is unlikely that unrelated taxons would have a similar set of indicator signs. If, however, this set is similar, it would indicate a genuine relationship of taxons and would speak against the possibility of parallel appearance thereof.

The method of correlation pleiads, which originally was intended to meet the needs of systematics, is presently used extensively by other branches of biology.

The work of B. R. Vasil'yev and N. S. Rostova (1977) is a good example of applying this method to study plant morphogenesis; they used factored analysis in addition to correlation analysis. Of the greatest interest is the conclusion of these authors that the correlation between signs of the growing leaf of *Bryophyllum daigremontianum* Berger is higher than the correlation of signs in a leaf that has completed its growth.

The method of P. V. Terent'yev found application in geobotany (for example, Neshatayev, 1969, 1971; Mirkin, 1969, 1971; Khanov et al., 1969; Lobanova, 1971; Aleksandrova et al., 1971, etc.). This method made it possible, in the field of comparative horticulture [floristics], to classify the flora according to the degree of similarity of different characters (Rebristaya, Shmidt, 1972; Zaki, Shmidt, 1972, 1973a, b; Shmidt, 1974, 1975; Shmidt, Baranova, 1975). The method has also been used in zoning flower-bearing plants to rayons in Pskovskaya Oblast (Baranova et al., 1971).

There is a direct practical application of the method of correlation pleiads. P. V. Terent'yev (1960) had already demonstrated its potential for the study of dynamics and prediction of number of fur-bearing animals in different years, which permits development of recommendations on hunting them and replacing stock.

Several works demonstrated the important role of studying correlation pleiads in breeding cultivated plants (Matviyenko, 1971; Shakhla, 1973; Aristarkhova,

Ivanyukovich, 1976; Rostova, Kolodyazhnyy, 1976; Fadeyeva et al., 1976; Ivanyukovich et al., 1977, etc.).

The foregoing warrants the conclusion that, while P. V. Terent'yev (1960) himself considered his method to be referable to so-called R-technique of correlation analysis (Cattell, 1952), which deals with the correlation of characters of individuals in a sample, at the present time it is apparent that there is equal justification for referring this method to Q-technique, which deals with correlation of individuals or taxons according to a number of features, i.e., grouping thereof. It should also be noted that the method of correlation pleiads makes it possible to use as the gage of correlation not only the coefficient of linear correlation ( $r$ ) or correlation ratio ( $\eta$ ), but any other index of correlation or coefficient of similarity. All this broadens markedly the area of application of the method, which can be used not only to solve special problems of systematics, but to construct phylogenetic systems, as well as in many other situations when the biologist has to investigate the internal system of correlations of features in the object of his concern.

#### Taxonomic Analysis

Since 1960, Ye. S. Smirnov published several articles, in which he successively developed the fundamentals of his method (1960, 1963, 1966, 1968, 1971a, b). In 1969, these data were summarized in book form, "Taxonomic Analysis"; however, work continued to refine the method. The articles of Ye. S. Smirnov entitled "Coding of Signs for Taxonomic Analysis" and "Some Problems of Precise Systematics," which were published in 1971, provide the most substantial supplementation to the book.

The method of taxonomic analysis of Ye. S. Smirnov is referable to the category of weighted methods, and in this respect it is basically the opposite of the nonweighted procedures of "numerical taxonomy" that is popular in the West (Sneath, Sokal, 1962; Sokal, Sneath, 1963, and others). As we know, the starting point for "numerical taxonomy" was the revival of a postulate of the old French botanist, M. Adanson (1727-1806) concerning the taxonomic equivalence of all features, which had been rejected in the course of development of systematics. As a result, inclusion in mathematical analysis of as many (not infrequently several hundred) features as possible ensued from this, as well as the hypothesis of "nonspecificity of signs" (Sokal, 1968), which maintains that any set of a large number of signs equally represents the genotype and allows for the possibility of constructing a system of signs of any part of the plant or animal body, signs of different tissues, ontogenetic stages, etc. In practice, this means that one can construct a classification on the bases of a group of correlated signs, which is inadmissible in our opinion. To construct a classification, one should try to use a set of independent features (Takhtadzhyan, 1966), and taxonomists are aware of the fact that if this set is biologically correct, it can describe well a taxon and distinguish it from other taxons.



Signs are far from equivalent, and each of them contains a different amount of taxonomic information. B. A. Vaynshteyn (1972) is right in maintaining that a large number of signs cannot compensate for lack of knowledge about their importance. V. G. Kovalev and A. I. Shatalkin (1969) put it even more harshly, indicating that by following the principle of Adanson the work of the taxonomist is transformed into a system of mathematical operations deprived of biological meaning; H. Ross (1964) also wrote that "... numerical taxonomy is an excursion into emptiness."

Even if we assume that these statements are extreme, although we consider them valid, we cannot fail to recognize the fact that "numerical taxonomy," which presumes to be the most objective method, is indeed far from being free of elements of despicable "subjectivity." It is inconsistent if only because it does not reject the concept of biological species, which inevitably contains the same "subjectivity" against which it fights. "Numerical taxonomy" also allows for some arbitrariness in the choice of coefficients of similarity (each of which has its own significance and leads to a somewhat different results), as well as in the final grouping of "phenons," which can be done by different methods (i.e., it can vary). Typically enough, R. R. Sokal (1968) is unable to voice a preference for a specific coefficient or method. Finally, "numerical taxonomy," which requires rejection of freedom of choice of signs by the researcher, at the same time recommends that one exclude from analysis signs that are very variable or closely correlated, which do not confirm with the definition of so-called "unique signs." This can also serve to demonstrate its inconsistency.

Ultimately, we should recognize the validity of the opinion of M. R'yuz (1977), who states that "numerical taxonomy" does not reach its goals. But we cannot agree with the compromise conclusion of this author that, depending on the researcher's interests, occasionally "evolutionary" and occasionally "phenetic" (i.e., "numerical") taxonomy may be best. Evolutionary taxonomy will always be best, and we must strive toward it.

Recognizing the vulnerability of the Adansonian postulate, some proponents of "numerical taxonomy" (Proctor, Kendrick, 1963; Hall, 1965; Williams, 1969; Legendre, Rogers, 1972, and others) have repeatedly tried to perform a unique "weighing" of signs by different methods, within the confines of their conception. But these were eclectic attempts, since one cannot reconcile the irreconcilable. The question can only be resolved in the following manner: either we "weigh" the sign on the basis of a specific biological criterion and only then submit the data to mathematical processing, or we overlook the taxonomic dissimilarity of signs, in the hope that the large number thereof will automatically lead to the correct results. Rejecting the second route, we encounter the question of how exactly are we to "weigh" the signs. Since the ultimate goal of systematics is to construct a classification that reflects the true relationship of taxons, it would be best to "weigh" the tags on the basis of their phylogenetic significance. Unfortunately, we do not know the phylogenetic significance of tags (particularly for taxons of a low rank, for example, species) in most cases, and it cannot be determined. M. G. Pimenov (1968) validly observes that actually



there remain only two possible routes for "weighing" signs: on the basis of incidence (frequency) and on the basis of correlation. The second of these criteria requires complete analysis of the correlation structure of objects, and use thereof is limited to special cases. In his routine work, the taxonomist must be governed primarily on the frequency of tags, which is more accessible to investigation.

However, even on the basis of frequency, signs can be "weighed" by technically different methods and, mainly, on the basis of different basic sets. For example, the method of P. P. Gambaryan (1964, 1968 and others), which estimates the frequency by the amount of information that is numerically equal to the entropy of the system in question, attributes the largest taxonomic weight to frequently encountered tags, i.e., he combines taxons with a similar set of commonplace [trivial] tags. Serious objections are raised against such an approach to evaluation of tags (Shmidt, 1970a, 1975; Tamarin, 1971a, b, 1973), which consist of the fact that, from the standpoints of both information theory and correlation theory, scarce tags are more informative and more independent than frequent ones and, consequently, to expressly the scarce tags a higher taxonomic weight should be attributed.

This stipulation served as the basis of the method of taxonomic analysis of Ye. S. Smirnov, who approximates taxons with similar set of scarce tags.

As we know, the taxonomic relationship between two species is defined by the formula:

$$I_{ij} = \frac{1}{n} \sum_{\alpha} w_{\alpha} \quad (1)$$

where  $n$  is the number of signs,  $w_{\alpha}$  is the weight of coincidence and non-coincidence thereof in the species compared.

The weights of coinciding signs are calculated as the reciprocals of their frequency, and thereby the rare signs obtain a higher weight. The weights of noncoincidence of tags are always expressed by a negative unit.

If we use the symbol  $\beta_i$  to refer to the frequency, the formula of taxonomic relationship acquires a form that is more convenient for calculations:

$$I_{ij} = \frac{s}{n} \sum_{i=1}^s \left( \frac{1}{\beta_i} \right) - 1 \quad (2)$$

where  $s$  is the number of species,  $n$  is the number of tags and  $f$  is the number of coinciding tags in compared species.

The specific distinction of the method of Ye. S. Smirnov is that one can use equations (1) or (2) to calculate the taxonomic relationship of a species to itself ( $t_{xx}$ ). Of course, all of the tags of the species coincide with one another and, at first glance, it appears that all species should have the same values of  $t_{xx}$ , which equal one (and, incidentally, this is exactly what is obtained by the method of P. P. Gambaryan). However, the essence of the method of taxonomic analysis consists of the fact that, by "weighing" the tags, we are actually determining the degree of their uniqueness. Different species have a set of signs that differs in its uniqueness: in some species, there are more rare tags and the set thereof "weighs" more; in others there is prevalence of commonplace tags and the set thereof "weighs" less. Hence, the fact that, in the general case  $t_{xx} \neq 1$  becomes understandable and significant. This index is a gauge of the information capacity or degree of taxonomic originality of the species in the system of its genus. The higher the value of  $t_{xx}$ , the more individual [separate] the position of this species among others.

Ultimately, the existing taxonomic information is distributed among species proportionately to the frequency of tags in such a unique manner [only possible manner] that in the ultimate matrix all values of  $t_{xy}$  and  $t_{xx}$  are found to be specifically related (for example,  $2\bar{t}t_{xy} + \bar{t}t_{xx} = 0$ ), and this can, incidentally, be used to check the accuracy of calculations.

The question of the role of rare tags, to which a large weight is given by the method of Ye. S. Smirnov, is very important to taxonomy. The difficulty lies in the fact that the scarce tags may differ in age and origin. They may be ancient (preserved in part of the species) and young (inherent in relatively recent species), i.e., while having the same frequency (given the same weight), they may be characterized by a different content in the sense of taxonomic information. Moreover, rare tags (both ancient and recent) may occur convergently or in parallel in unrelated taxons. Since it is usually difficult to take all these circumstances into consideration on the species level, the question arises: would not evaluation of similarity obtained by the method of taxonomic analysis be distorted under such conditions?

With reference to convergence, it should be stated that, while appearance of some similar signs on its basis is not such a rare phenomenon, convergent formation of an entire set of rare tags is an extremely improbable phenomenon (Takhtadzhyan, 1966). This means that only some convergently occurring tags may be included in taxonomic analysis, and they are incapable of distorting appreciably the result that is made up on the basis of consideration of many signs.

It is more difficult to establish the probability of parallel occurrence of rare tags in unrelated taxons, but even this can be done on the basis of analysis of correlation structure (Takhtadzhyan, 1966).

In this respect, the study conducted by P. V. Tamarin (1971a, b, 1973) of taxonomic value of scarce signs from the standpoint of mathematical theory

of correlation acquires special significance. He demonstrated that rare tags determine, more accurately than frequent ones, the frequency of the other tags and, consequently, a more distinct classification is obtained on their basis. In spite of the opinion of P. P. Gambaryan (1968), rare tags are correlated the least. This means that, by virtue of their relative independence, rare tags are close in taxonomic value to the significance of indicator tags of correlation pleiads, even though they are not necessarily such indicators in reality.

We see that the foregoing has bridged the gap between taxonomic analysis and the method of correlation pleiads. Following another route, Ye. S. Smirnov developed a method which, as it turned out, can be interpreted from the standpoint of correlation theory and thereby it touches upon the pleiad method of P. V. Terent'yev! Indeed, what are, let us say, intrageneric congregations of species, referred to by systematicians as subgenera, sections or species ranks, if not pleiads. This idea can also be formulated in a different manner: by performing taxonomic analysis according to Ye. S. Smirnov, we are performing in an inapparent form (without calculating the coefficients of correlation) correlation analysis referable to the category of Q technique.

We should also mention other aspects of mathematical substantiation of the method of Ye. S. Smirnov, offered by P. V. Tamarin (1971a, b, 1972, 1973). He substantiated the concept of "originality of tag" from the standpoint of information theory, and he demonstrated that the "weight of uniqueness" corresponds to the "specific weight" of the tag in the terminology of Ye. S. Smirnov. In spite of some doubts (for example, Vasilevich, 1969), there was confirmation of the validity of evaluating noncoincidence of tags with a negative unit.

Let us add that the method of taxonomic analysis was also substantiated by A. A. Dyul'din (1973) from an utterly different mathematical standpoint, from the standpoint of Boolean functions and variables. Inclusion thereof in the guide of mathematical algorithms of classification served as recognition of validity of the method (Dorofeyuk, 1971).

Like the method of correlation pleiads, the method of taxonomic analysis has withstood the test of time, in the course of which the area of its application has broadened appreciably. The method is being used with success, not only in a number of studies dealing with systematics and ecology of animals (Pichka, 1965; Rasnitsyn, 1965; Zhantiyev, 1967; Kovalev, 1968, 1969; Kovalev, Shatalkin, 1969; Shatalkin, 1968, 1973; Toskina, 1974) and plants (Shmidt, 1962, 1970a, b; Rukhadze, 1968; Osetrov, 1969, 1970, 1974; Oktaba, Chmielnicka, 1971), but also in the field of physiology of insects (Ioffe, 1965), comparative floristics (Shmidt, Baranova, 1975) and even in "scientific metrics" ["naukometriya"?] (Korennoy, Osetrov, 1974). This method was shown to be important to development of phylogenetic problems (Kovalev et al., 1974; Osetrov, 1974). A punchcard variant of the method has been developed (Osetrov, 1970); weight tables have been prepared (Tamarin, 1972) and simple algorithms have been proposed (Zaytsev, 1976); all this alleviates and accelerates computing work significantly.

We have already mentioned the high degree of universality of these methods. But, in conclusion, we cannot fail to return to systematics, for the sake of which they were originally conceived. The fact of the matter is that a somewhat paradoxical situation developed in this discipline: the more we experience an understandable desire for mathematical argumentation of systematic and phylogenetic conceptions, the more we realize that there is no standard systematics theory! In our opinion, taxonomy, which refers to the general teaching on the principles and methods of classification (Takhtadzhyan, 1966), a teaching on taxonomic categories, should become this theory. This teaching includes investigation of the structure of taxonomic categories, on the one hand, and investigation of the structure of correlations between tags or taxons, on the other. We have seen that the former is resolved by the method of taxonomic analysis and the latter, by the method of correlation pleiads. Thus, both methods and directions confirm entirely with the tasks of taxonomy, and they should play an important role in development of theory of systematics.

At the same time, both methods help construct the most objective classification systems. For this reason, it would not be an exaggeration to state that they constitute a rather effective mathematical apparatus, especially when applied together to the same material, both for development of theory of systematics and for solving practical problems of classification and phylogenetics.

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## ERGONOMICS

### PRINCIPLES OF ERGONOMIC STANDARDS DISCUSSED

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[Article by V. Munipov, Cand Psych Sci, Head, Coordination Center for the Problem "Development of the Scientific Principles of Ergonomic Standards and Requirements": "Development of the Scientific Principles of Ergonomic Standards and Requirements"]

[Text] The plan for the coordination of scientific and technological research performed by the member countries of CEMA in 1976-1978 includes the complex problem "Development of the Scientific Principles of Ergonomic Standards and Requirements." The program for collaboration on this problem, adopted in December 1974 in Sofia, includes 10 topics subdivided into 260 autonomous subtopics. The program is implemented with the participation of 61 organizations in seven countries: Bulgaria, 8; Hungary, 3; the GDR, 5; Poland, 5; Rumania, 2; the Soviet Union, 26; Czechoslovakia, 12. The functions of the Coordinating Center are handled by the All-Union Scientific Research Institute of Engineering Aesthetics in Moscow.

The determining factor in the accelerated development of ergonomics in the socialist countries and in their organization of multilateral cooperation for this purpose is that precisely socialism is capable of subordinating production to the tasks of the broad development of man, implementing a program for the humanization of human relations, and orienting the scientific and technological revolution toward the solution of social problems.

The current development of ergonomics is characterized by fairly intensive research into problems of its theory and methodology. These problems rank uppermost in the collaboration program. Unless these problems are solved, it is hardly possible to assure the fruitful international development of such a complex problem as the creation of the scientific principles of ergonomic standards and requirements, inclusive of research into allied branches of many sciences (sociology, psychology, economics, physiology, hygiene, anthropology, cybernetics, etc).



A study of the methodological situation in ergonomics, conducted by scientists in the socialist countries, has isolated several specific features of the present-day state of ergonomics and resulted in a concrete analysis of these features. Certain starting concepts of ergonomics have been refined, and greater clarity has been introduced into the treatment of a large number of ergonomic assumptions. This primarily refers to the definition of the subject matter itself of ergonomics.

Currently ergonomics can be viewed as a nascent scientific discipline concerned with man (group of individuals) in relation to particular conditions of his (or their) activity associated with the use of technology. Ergonomics regards man, machine and environment as a complex functioning whole in which man plays the leading role. The status of ergonomics is determined by the fact that it operates with data obtained in other sciences, converts them into its own starting premises and means, and pursues its own aims and problems relating to the organization and design of the conditions and methods of man's activity in a system.

The principal subject of ergonomics is the "man-machine" system, and this science investigates the properties of that system most closely related to its efficiency of performance and termed "human factors." This term, conceived in the dawn of ergonomics and human engineering, has been defined as follows in the light of recent research into theory and methodology: human factors are the integral characteristics of the relationship between man and machine as manifesting themselves under specific conditions of their interaction during the functioning of the "man-machine" system relating to the attainment of a specific goal. Hence it follows that human factors cannot be reduced to the inherent characteristics of man, machine and environment. Naturally, these factors are isolated with the aid of the basic knowledge available on each of them in the corresponding sciences. But the characteristics and properties figuring in the concept of human factors represent not discrete, isolated qualities of the components of the "man-machine" system but its combined, systemic qualities.

Ergonomics is interested not in all the possible "primary" qualities of man, machine and environment, but only in those determined by man's position and role in the system (that is why they are termed human factors). It is precisely man's activity that serves as the basis for isolating the human factors that count, for determining the functional relations between the components of the "man-machine" system. It is just as valid that the existence of such functional relations provides the necessary basis for the organization and implementation of man's activity in the system.

Man's activity is the beginning and end of ergonomic research, ergonomic assessment and ergonomic design. The concept of man's activity also serves as the theoretical basis for the treatment of human factors given above. Hence, ergonomics forms new conceptual treatment of that activity and new methods for its analysis, which stimulates the development of the general theory of human labor. That theory includes the particularization and

assessment of the true role of instruments of labor (technological equipment) which amplify and transform human functions and possibilities, i.e. which represent the externalized means of human labor.

On the basis of the Marxist doctrine of objectivized activity, its development, and forms, a productive application of ergonomic research to the theory and methodology of human labor has become outlined. The effective solution of ergonomic problems is possible only that "if the synthesis of social and natural sciences will follow not along the path of a mechanical combination of the data of some or other particular sciences into some composite system or conglomeration of knowledge, nor along the path of their 'co-subordination,' but will be based on the general theory of human labor."<sup>1</sup>

Ergonomics should assure the determination of the necessary and sufficient variety of functional relations among the components of the "man-machine" system, since only then that system can acquire the status of a system displaying a specified effectiveness and satisfying specified criteria.

That variety of functional relations should be constructive but not infinite and should satisfy a large number of criteria for evaluating the "man-machine" system--both technological (stability, reliability, noiseproof performance) and socio-economic. Its concrete expression is that ergonomics does not just deal with various systems of input properties and quality indicators (hygienic, physiological, psychological, socio-psychological, technological, ecological, etc) obtained from the corresponding sciences but also transforms them into systemic qualities on establishing the necessary number of functional relations among them.

The systems approach, which previously had not been a regular part of ergonomics, is currently becoming its principal methodological orientation. It makes possible a correct statement and solution of problems of the classification of the "man-machine" system, of ergonomic criteria, of the objects of standardization in ergonomics, etc. Systems approach has been used, e.g. to determine the structure of the ergonomic properties and indicators of the "man-machine" system displaying such composite properties as controllability, serviceability, assimilability and habitability. The integral index of ergonomicity characterizes the extent to which all ergonomic requirements have been taken into account in a system.

Ergonomics is both a theoretical discipline and an applied, practical discipline, since its purposes include the development of methods for taking human factors into account in the modernization of existing equipment and technology and development of new equipment and technology. This aspect is inherent not only to ergonomics. Recently there has arisen a tendency

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<sup>1</sup>"Strengthen the Relationship Among Social, Natural and Technical Sciences," KOMMUNIST, 1977, No 1

termed the technologization of social sciences; there appeared studies dealing with problems of Marxist social technology.<sup>2</sup>

The range of objects designed with the participation of ergonomic experts extends from automated control systems (ASU) to electric shavers. Thus, an analysis of the performance of operative and centralized ASU stations at existing enterprises revealed typical shortcomings in the ergonomic plane and served to outline ways of exploiting the available potential for improving the organization of operative control and working conditions and increasing the productivity of technological objects.

A major shortcoming of a number of operative control systems is incomplete mechanization. Hence the substantiation of a rational or even optimal distribution of functions among operators and automatic equipment and the attendant improvements in the control of principal machinery units directly from central control points represent an important potential for increasing the efficiency of corresponding production. A major potential for enhancing the efficiency of the labor activity of human operators is the provision of optimal hygienic working conditions as well as the assurance of an esthetic organization of control points.

Ergonomic experts also perceive other no less important kinds of potential for improvement by participating in the design of mass consumer goods, inclusive of cultural-communal products; then the basic principle of ergonomics--a maximum of attention to man<sup>3</sup>--is translated into reality.

The joint intensive research into theoretical and methodological problems of ergonomics by the scientists of the socialist countries has resulted in a relatively rapid drafting of a basic prospectus and guide: "Ergonomics: Principles and Recommendations." That guide served as a basis for developing the first edition of a guide designed for production organizers, engineers and designers.

The solution of problems of theory and methodology largely determines the productivity of the joint development of terminology. Plans exist for formulating recommendations for the standardization of ergonomic terms and drafting material for an international terminological CEMA standard on ergonomics.

Of major importance to the solution of problems of theory and practice is the determination of unified ergonomic criteria for the optimization of

<sup>2</sup>See, e.g., N. Stefanov. "Obshchestvennyye Nauki i Sotsial'naya Tekhnologiya [The Social Sciences and Social Technology]. Moscow, Progress, 1976 (translated from the Bulgarian).

<sup>3</sup>For more detail see V. M. Munipov. "Current Status and Developmental Tendencies of Ergonomics and Human Engineering." VOPROSY PSIKHOLOGII, 1978, No 1.

"man-instrument of labor-production environment" systems, including indexes of improvements in the hygiene and conditions of work and life of workers, as well as indexes of labor productivity. The task of the ergonomists consists in developing optimal criteria for all these indexes simultaneously. This task is being implemented with the participation of 40 organizations of the member countries of CEMA.

Work to implement the task of "Determination of Anthropometric Data in Relation to Problems of Machine Design" is proceeding on the basis of agreed-upon methodology. Considerable anthropometric material on population groups in the CEMA member countries has been gathered. It is represented by atlases, monographs, guides. All this material is of great importance not only to practice but also to theory, as it serves as a basis for a new domain of applied anthropology—ergonomic anthropology, which pursues problems of its own, has a definite subject matter, and is distinguished by specific experimental methods and by a special domain of application of its findings.

A unified theoretical concept is being formulated and methodological principles of joint research are being worked out with respect to the problems: "Development of Physiological and Psychophysiological Criteria," "Development of Psychological Criteria," "Development of Socio-Psychological and Sociological Criteria."

It should be noted that the establishment of unified sociopsychological and sociological criteria is of fundamental importance to the industry of the socialist countries, to those conditions of true collectiveness discussed by Marx<sup>4</sup> which is associated with a high level of development of material production on the basis of public ownership of the instruments and means of production. In this connection, it is difficult to overestimate the importance of research into sociopsychological factors, which directly affect the nature and results of human labor. In this connection, research into the motivational aspect of human labor, inclusive of interaction in work groups and collectives, is of primary importance.

With respect to the task "Development of Technical-Esthetic Criteria," a classification of the esthetic factors of working condition has been drafted and criteria for their evaluation have been prepared, as have been methodological recommendations and materials.

The methodological principles of the organization of human labor and systems according to ergonomic criteria are being worked out. In particular, the results of the practical application of ergonomic standards and requirements to a scientific organization and safety of labor are being investigated, and methodological postulates assuring the overall consideration of these standards and requirements in production are being drafted. All this will serve

<sup>4</sup>See K. Marx and F. Engels, "Sochineniya" [Collected Works], Vol 3, p 75.



to markedly broaden the range of practical applications of the principles and methods of ergonomics and contribute to a more effective solution of the problems of the scientific organization and safety of labor.

As is known, the problem of the limitations on human motor activity is becoming increasingly topical in view of the increase in the proportions of occupations involving mental and light physical labor. Hence research into the necessary motor activity of the human operators subjected to hypokinesia and hypodynamics is extremely promising. The findings of that research will be formulated in "Methodological Recommendations for Determining the Extent of and Preventing the Unfavorable Consequences of Hypokinesia [in People] at Work." These will reflect the criteria for evaluation and prevention of hypokinesia by taking into account corresponding data when designing machinery, production equipment and labor processes, the elimination of hypokinesia in the organization of labor, and the compensation of occupational hypokinesia during leisure-time hours.

The accomplishment of the task of further elevating the living standards in the countries of the socialist community is chiefly predicated on qualitative indexes, and in particular on improvements in the quality of manufactured consumer goods and commodities. Hence the joint research into the problem of standardizing the principal criteria for the ergonomic evaluation of the quality of industrial output and technological processes is becoming particularly topical.

Of undoubted value is the determination of ergonomic requirements for data-reproduction equipment as a most important component of "man-machine" systems. Bulgarian and Soviet scientists have written on this topic the collective monograph "Psikhologicheskiye Problemy Adaptatsii Informatsionnogo Vzaimodeystviya Cheloveka i Mashiny" [Psychological Problems of the Adaptation of Informational Man-Machine Interaction] (in print). The data in that monograph provide the methodological basis for drafting practical recommendations for the design of data-reproduction equipment.

In 1977 the "Interbranch requirements and Normative Material for a Scientific Organization of Labor" were approved in the USSR. They should be taken into account in the designing of new and modernization of old enterprises and in the development of technological processes and equipment. This document contains the results of international research into ergonomic problems conducted within the framework of CEMA. In addition, four proposals for national standards and six other normative-technical and methodological documents concerning ergonomics have been drafted.

The development of ergonomics as a practical domain of activity is largely determined by the level of the economic substantiation of the corresponding research and development work. The interrelationship and interdependence of the economic and social effects of scientific and technological progress results in that the problem of economic effectiveness becomes also a problem of socioeconomic effectiveness. The effects of new technology on society



represent a condition for implementing the potential economic effect latent in that technology.<sup>5</sup>

Investigating the problems of the socioeconomic effectiveness of the introduction of ergonomic achievements into the national economy, the Institute of Industrial Design (Czechoslovak SSR), the Scientific Research Institute of Labor (USSR) and the Scientific Research Institute of Economics and Organization of Machine Building (Bulgarian People's Republic) have completed their work to develop the first draft of methodological recommendations for evaluating the socioeconomic effectiveness of the introduction of achievements of ergonomics into the organization of labor.

While this work should be positively assessed, attention must be drawn to major difficulties encountered by the persons engaged in it. These difficulties can be surmounted only if the theoretical aspects of the principal problems of the socioeconomic effectiveness of ergonomics are delved into more deeply. Thus, a fundamentally new formulation is needed for many problems, and primarily for the problem of the relation of social and economic effects to the introduction of achievements of ergonomics into the national economy. Special examination is deserved by the question of a specific formulation of social and hence also ergonomic indexes of technology on the basis of the most economic variant assuring the attainment of a concrete social purpose at the least capital and current expenditures.

A preliminary assessment of the collaboration of CEMA member countries in the development of the scientific principles of ergonomic standards has been presented at the Third International Conference on Ergonomics (Budapest, August 1978) and the Fourth Session of the Council of representatives on this problem (Sofia, December 1978).

The participants in the conference and session noted that collaboration enables the CEMA countries to save efforts, resources and time spent on the solution of important scientific and technical problems of ergonomics and to utilize the resulting findings in various sectors of the national economy. Such joint research into ergonomic problems has been a major factor in the development of this scientific discipline both in the individual socialist countries and in the socialist community as a whole, and it has made it possible to obtain major findings of theory and practice, many of which are of great importance to the national economy.

During the drafting of the program of scientific and technical collaboration for the coming five-year period, it was resolved to focus efforts on the development of a set of CEMA standards on ergonomics and to include corresponding requirements in other CEMA standards as well. In addition, a proposal

<sup>5</sup>See "Metodologicheskiye Voprosy Opredeleniya Sotsial'no-Ekonomicheskoy Effektivnosti Novoy Tekhniki" [Methodological Aspects of the Determination of Socio-Economic Effectiveness of New Technology], Moscow, Nauka, 1977.

was made for examining the problem of the expediency of implementing the complex whole of activities needed to establish an ergonomic data bank with the object of further development of a system of corresponding CEMA standards and national normative-technical documents, as well as of providing ergonomic criteria for design work.

The recommendations and resolutions adopted at the Conference and the Council Session emphasize that the principal prerequisite for an effective development of ergonomic research and practical utilization of its findings is the solution of the problem of special and advanced training of scientists in ergonomics. To this end, joint development of typical training programs, lecture courses and textbooks on ergonomics is planned for the coming five-year period.

The collaboration of the scientists and experts on ergonomic problems in the CEMA member countries contributes to the most rapid and effective utilization of achievements of ergonomics with the object of optimizing working and living conditions, protecting the health and development of the human personality, increasing labor productivity, and improving the quality of production.

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EFFECT OF THERMAL TREATMENT ON THE CONTENT OF RESIDUAL AMOUNTS OF CHLORTETRACYCLINE AND TETRACYCLINE IN SOME CHICKEN TISSUES

Moscow VOPROSY PITANIYA in Russian No 2, 1979 received by editors 2 Dec 77  
pp 74-75

Article by G. A. Shakaryan, Z. M. Akopyan and T. K. Sevyan, Department of Microbiology (Prof G. A. Shakaryan, head) of the Yerevan Zooveterinary Institute/

Text The use of antibiotics and their combinations with other chemopreparations in veterinary science, livestock breeding and the food industry is connected with the possible danger of their long retention in food products of animal origin and, therefore, transfer to the human body with a systematic use of such products, which ultimately can be the reason for the occurrence of various undesirable phenomena in the human body (formation of resistant microbe strains, sensibilization of the human body to one or several antibiotics, as a result of which the subsequent therapeutic prescription of antibiotics to sensibilized individuals will be contraindicated owing to the development of allergic reactions and so forth).

In order to eliminate the risk to human health, it is necessary to strictly observe the instructions for the use of antibiotics in livestock breeding and veterinary science.

In the literature there are works of both Soviet and foreign authors, who studied the effect of thermal treatment on the residual amount of antibiotics, in particular of the tetracycline group, in the meat and subproducts of poultry (1, 2, 4-7).

The object of these investigations was to clarify the effect of various periods of thermal treatment (60, 30 and 20 min) on the content in some chicken tissues of residual amounts of chlortetracycline, tetracycline and their combinations with the sulfanilamide preparation phthazine.

Experiments were conducted on 12 chickens. Chickens of one group received chlortetracycline in a single oral dose of 100 mg/kg and of the other group, tetracycline in the same dose. In another series of experiments chickens of

one group received chlortetracycline in a single oral dose of 100 mg/kg in combination with phthazine in a dose of 20 mg/kg and of the other group, tetracycline in the same dose with phthazine in a dose of 50 mg/kg.

The chickens were killed 2 hours after the administration of these preparations. Muscles, gizzards and livers were examined for the content of residual amounts of antibiotics in them before and after culinary processing.

Muscles were subjected to boiling for 30 min and 1 hour, livers, for 20 min and gizzards, for 1 hour. Beef broth was also examined.

The residual content of antibiotics was determined by the well-known microbiological method of diffusion in agar [3].

After the chickens were killed, residual amounts of both chlortetracycline and tetracycline were detected in the examined tissues (see table).

High concentrations of chlortetracycline and tetracycline were detected in the liver—6.58 and 4.49 units of action/g—and in muscles—1.78 and 5.63 units of action/g. A total of 0.88 units of action/g of chlortetracycline and 1.47 units of action/g of tetracycline were detected in the gizzard.

After the boiling of the indicated tissues the amount of antibiotics was sharply lowered as compared with the initial amount. The content of tetracycline was lowered more intensively in muscles.

Whereas after a 30-min boiling of muscles containing chlortetracycline its residual amounts remained within 10.6% and after an 1-hour boiling, within 7.3% of the initial amount, after a thermal effect for 30 min tetracycline (whose amount in raw muscles was more than triple the amount of chlortetracycline) remained in the form of traces and after an 1-hour boiling was no longer detected. Evidently, under the effect of the heat factor tetracycline is more intensively inactivated in chicken muscles.

Chlortetracycline was not detected in meat broth and traces of tetracycline were detected only after a 30-min boiling of chicken meat.

In the boiled liver and gizzard residual amounts of tetracycline exceeded the content of chlortetracycline.

Whereas in the boiled liver tetracycline remained within 37.6% and in the gizzard, within 56.4% of the initial amount, in the liver chlortetracycline remained within approximately 23% and in the gizzard, only within 1.1% of the initial amount.

Evidently, the varying degree of inactivation of tetracycline and chlortetracycline in the liver and gizzard of chickens after thermal treatment is connected with the level of initial concentration of an antibiotic in a



product, with the chemical structure of the preparation and, perhaps, also with the varying degree of interaction of antibiotics with the proteins of liver and gizzard tissues.

# Residual Amount of Chlortetracycline and Tetracycline in Chicken Tissues

(1) Объект исследования	(2) Хлортетрациклин			
	(3) в сыром продукте	(4) после термической обработки продукта		
		(5) 20 мин	(5) 30 мин	(5) 60 мин
(7) Мышцы (6)	1.78±0.51	—	0.19±0.01	0.13±0.06
(7) Мышечный желудок (8)	0.88±0.07	—	—	0.10±0.06
Печень (8)	6.58±0.65	1.5±0.94	—	—
Мясной бульон (9)	—	—	0	—
(10) Тетрациклин				
(7) Мышцы (6)	5.63±0.84	—	Следы (11)	0
(7) Мышечный желудок (8)	1.47±0.82	—	—	0.83±0.09
Печень (8)	4.49±0.46	1.69±0.78	—	—
Мясной бульон (9)	—	—	Следы (11)	0

Продолжение (12)

(1) Объект исследования	Хлортетрациклин + Фтазин (13)			
	(3) в сыром продукте	(4) после термической обработки продукта		
		(5) 20 мин	(5) 30 мин	(5) 60 мин
(7) Мышцы (6)	4.9±0.45	—	0.23±0.08	0.088±0.049
(7) Мышечный желудок (8)	1.04±0.07	—	—	Следы (11)
Печень (8)	2.97±0.26	0.013±0.009	—	0
Мясной бульон (9)	—	—	0	0
(14) Тетрациклин + Фтазин				
(7) Мышцы (6)	3.22±0.005	—	0	0
(7) Мышечный желудок (11) Следы	—	—	—	1.6±0.02
Печень (8)	3.1±0.04	0.33±0.025	—	—
Мясной бульон (9)	—	—	(11) Следы	0

Remark. In muscles, gizzards and livers the antibiotics were determined in units of action/g and in meat broth, in units of action/ml.

## Key:

- |   |                                 |
|---|---------------------------------|
| 1. Object of investigation                | 8. Liver                        |
| 2. Chlortetracycline                      | 9. Meat broth                   |
| 3. In raw product                         | 10. Tetracycline                |
| 4. After thermal treatment of the product | 11. Traces                      |
| 5. Min                                    | 12. Continuation                |
| 6. Muscles                                | 13. Chlortetracycline+phthazine |
| 7. Gizzard                                | 14. Tetracycline+phthazine      |

During an examination of the boiled meat products and chicken meat, which received chlortetracycline and tetracycline together with phthazine, it was established that a reduction in the amount of antibiotics in a product under the effect of thermal treatment occurs according to the same patterns as during a separate use of antibiotics.

Whereas in chicken muscles after a 30-min boiling chlortetracycline remained within 4.5% and after an 1-hour boiling, within 1.8% of the initial amount, after a 30-min boiling tetracycline was not detected in chicken muscles.

However, in the liver and gizzard after thermal treatment tetracycline remains at a higher level than chlortetracycline. For example, whereas in the boiled liver chlortetracycline remained only within 0.4% of the initial amount, tetracycline, within 10.6%.

In meat broth only traces of tetracycline were detected after a 30-min boiling of muscles.

#### Conclusions

1. Tetracycline in chicken muscles was completely destroyed during a 30- to 60-min boiling.
2. Chlortetracycline in chicken muscles remained partially after a 60-min boiling.
3. The sulfanilamide preparation phthazine does not increase the resistance of antibiotics of the tetracycline series to the effect of a high temperature.

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RESULTS OF STUDY OF POSSIBLE BLASTOMOGENIC PROPERTIES OF ISOBUTYLIDENDIUREA

Moscow VOPROSY PITANIYA in Russian No 2, 1979 received by editors 24 Mar 78  
pp 72-73

[Article by G. G. Didenko, T. D. Gupalovich and O. G. Petrovskaya, All-Union Scientific Research Institute of Hygiene and Toxicology of Pesticides and of Polymeric and Plastic Masses (Academician of the USSR Academy of Medical Sciences L. I. Medved', director), Kiev]

[Text] Now, when the decisive role of carcinogenic chemical agents in the etiology of tumor diseases has been demonstrated, the detection and elimination of carcinogens from the human environment have become the basic factors in cancer prevention. The intensive development of chemistry and synthesis of new preparations urgently require a study of their blastomogenic properties before their wide introduction into practice. This concerns primarily substances used in agriculture. Their residual amounts can be found in food products and, therefore, have an effect on large population groups of various ages.

In livestock breeding at the present stage of special importance is the use of synthetic fodder additives--sources of nonprotein nitrogen ensuring an important increase in the mass of farm animals. A derivative of urea--isobutylidendiurea (IBDU)--is one of such new preparations.

The results of investigation of the potential blastomogenic properties of isobutylidendiurea are presented in this work. In the literature there are data on the presence of blastomogenic properties in a number of compounds from the urea group--thiourea, thioacetamide, ethylenethiourea and monuron [1-6].

Materials and methods of investigation. A study of the blastomogenic nature of IBDU was conducted on noninbred mice and rats of both sexes with an initial mass of 18 and 80 g respectively. The preparation was administered to the animals intragastrically through a tube in the form of a water emulsion twice a week for 20 weeks in maximum tolerance doses, that is, 1,600 mg/kg to mice and 800 mg/kg to rats. The total length of observation of animals was 92 weeks. The presence of tumors was determined during the autopsy and



macroscopic investigation of animals that accidentally died or were killed. The internal organs of mice and rats of experimental and control groups were fixed in 10% formalin. The sections of organs with tumor or other pathological changes were subjected to histological treatment (embedding in paraffin and staining sections with hematoxylin and eosin) and to a microscopic study.

The results obtained and their discussion. The results of this experiment are presented in table 1.

Table 1. Results of the Experiment on Mice in the Study of Blastomogenic Properties of IHU

(1) Серия	(2) Продолжительность опыта, нед	(3) Пол	(4) Число умерших к 11-му месяцу*	(5) Число умерших с опухолями	(6) Частота образования опухолей, %
(7) Введение ИБУ	92	Самки {8} Самцы {9}	133 108	32 22	24.1 20.1
		Всего {10}	241	54	22.4
Контроль (11)	92	Самки {8} Самцы {9}	91 76	27 13	29.6 17.1
		Всего {10}	167	40	23.4

\*Tumors were not detected in animals that died or were killed before this period.

Key:

- |                                     |                                    |
|-------------------------------------|------------------------------------|
| 1. Series                           | 6. Frequency of tumor formation, % |
| 2. Length of the experiment, weeks  | 7. Administration of IHU           |
| 3. Sex                              | 8. Females                         |
| 4. Number of mice by the 11th month | 9. Males                           |
| 5. Number of mice with tumors       | 10. Total                          |
|                                     | 11. Control                        |

As a result of the examination of 241 experimental and 167 control mice, which lived until the appearance of the first tumor, it was established that the frequency of tumor formation in mice of both sexes during the administration of IHU did not differ in a statistically significant manner from control, comprising 22.4% in animals of the experimental group and 23.4% in animals of the control group. Tumors detected in mice of experimental and control groups appeared mainly during the late periods of examination, from 13 to 15 months from the beginning of the experiment, which

corresponds to the data in the literature on the dynamics of spontaneous tumor formation in mice. The localization of tumors and their description are indicated in table 2.

Table 2. Localization of Tumors and Frequency of Their Formation in Mice of the Control Group and During the Administration of IHOU

Опухоли (1)	Частота образования опухолей, %	
	введение ИБДМ (3)	контроль (4)
Аденомы в легких (5)	9,5	11,3
Опухоли молочной железы (аденофибромы, эпидермоидный рак) (6)	6,2	4,7
Лейкозы (7)	2,4	4,7
Аденокарцинома легких (8)	1,2	1,7
Мезотелиома (9)	1,6	1,1
Фиброма (10)	0,8	—

Key:

- |                                    |  |
|------------------------------------|--|
| 1. Tumors                          | 6. Tumors of the mammary gland (adenofibromas and epidermoid cancer) |
| 2. Frequency of tumor formation, % | 7. Leukoses  |
| 3. Administration of IHOU          | 8. Lung adenocarcinoma   |
| 4. Control                         | 9. Mesothelioma  |
| 5. Adenomas in lungs               | 10. Fibroma  |

A study of the blastomogenic effect of IHOU on rats showed that a 40-fold administration of high doses of this preparation during 20 weeks did not lead during 92 weeks to an increase in the frequency of tumor formation as compared with control (table 3).

Table 3. Results of the Experiment in the Study of Blastomogenic Properties of IHOU on Rats

Серия (1)	(2) Продолжительность опыта, нед	(3) Число животных		Частота образования опухолей, % (6)
		(4) всего	(5) с опухолями	
Введение ИБДМ (7)	92	82	6	7,3
Контроль (8)	92	63	5	7,9

Key:

- |                                    |                                    |
|------------------------------------|------------------------------------|
| 1. Series                          | 5. With tumors                     |
| 2. Length of the experiment, weeks | 6. Frequency of tumor formation, % |
| 3. Number of animals               | 7. Administration of IHOU          |
| 4. Total                           | 8. Control                         |

Tumors were detected in 7.3% of the animals that received IEDU and in 7.9% of the animals of the control group. Differences in the distribution of tumors depending on sex were not established in these groups.

Thus, evaluating the results of investigation of IEDU for blastomogenic properties obtained in long experiments on two types of animals (mice and rats), it can be concluded that under the conditions of the conducted experiments IEDU does not possess a blastomogenic activity.

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## INSTRUMENTS AND EQUIPMENT

### MINISUBS FOR DEEP-SEA EXPLORATION

Moscow TEKHNIKA MOLODEZHI in Russian No 4, 1979 pp 24-26

[Article by Aleksandr Durnev, engineer: "A Visit to Neptune"]

[Text] The American astronaut Scott Carpenter, who later became an aquanaut, once noted that tremendous wealth is hidden at the bottom of the oceans of the world. This treasure lies "...some 300 m below the dance floor of a luxurious ocean liner; but getting to it is harder than exploring the reverse side of the moon," [sic].

During the past fifteen to twenty years studies on, and exploitation of, the oceans of the world has assumed great importance. This is true not only for the present, but will continue to hold for the future; after all, Neptune's realm contains tremendous economic potentials which will satisfy the industrial, raw materials, as well as energy needs and other requirements of almost all the countries of the world. Let's limit ourselves to two examples: trawlers which ply the seas under the flags of various countries catch 60 million tons of fish every year. According to FAO [expansion unknown] experts, this figure will certainly double by 1985. This does not encompass the tremendous stores of plankton protein as yet untapped by man. And what about minerals? Although such a designation is not entirely appropriate, we should note that ocean water contains 90 billion tons of iodine, 5 billion tons of uranium, and at least 10 million tons of gold which, in addition to jewelry, is also used industrially. In addition, the ocean bottoms contain dispersed nuggets of rare metals.

We also have an interest in the development of these underwater treasures. After all, the shores of the Soviet Union are washed by 14 seas, of which 8 are in direct contact with the oceans of the world. The majority of them are in the North and the Far East. It is from these points that ships depart for long journeys; it is there that the unique Northern seaway is located and is traversed by hundreds of fishing ships ranging from the small seiners to huge floating factories. Huge fields of laminaria have developed in the Far Eastern seas--a highly tasteful alga which is utilized in over 25 branches of industry.

## Steps to the Depths

However, in order to utilize these reaches the oceans must be mastered to such an extent that we can feel as comfortable in it as a "fish in water." Until recently this was but a nice dream.

True, there was Jacques Yves Cousteau who has stated that "... in order to study the ocean's depths it is necessary to construct appropriate apparatus intended especially for underwater studies." Need was always the best driving force for progress, and it is because of such a need that we now have such equipment.

Currently, the history of these devices is divided into three phases. Up to the sixties there were individual efforts at making such underwater equipment. During the next ten years many became available and submarine experiments were undertaken. Finally, the seventies became known not only for complex studies on the oceans of the world, but also for the construction of specialized submarines and allied equipment, including submarine homes and laboratories.

Without going into the details of the rather involved classification, we can commence with equipment that is connected by a cable to a ship and capable of independent movement. Our "Severyanka" belongs in the latter category and is capable of movement under its own power; in addition, we have deep water technical equipment of limited potential for making excursions. They are carried to a given rayon by a tugboat or a carrier. Furthermore, submarines are generally classed into one of four categories. The first includes various apparatus for studying the continental shelf (maximum submersion is 600 m); the second group consists of equipment used in studies on the continental slope (two to 3.5 thousand meters). Representatives of the third group are used for the abyssal zone--the bed of the ocean--which lies six thousand meters below the surface. Finally, maximum depths, such as those of the Mariana depression, are accessible only to the Trieste or Archimedes type of bathyscaphe.

Many of us are full of stories of how American, French, Italian, or Japanese submarines visited the kingdom of the murky depths. Even the dry-land Swedes made it there. However, it would be erroneous to assume that our scientist did not start storming the depths until recently. Unfortunately, not many are aware that Soviet scientists undertook such studies over half a century ago!

## It All Began With a Legend

In 1923 the workers at one of the Moscow factories completed an unusual order: construction of a deep water research chamber according to the plans of fleet engineer Ye. Danilenko. This structure consisted of a cylinder with illuminators, manipulators, electric lighting, and a telephone--not bad for those days! The chamber was lowered by a steel cable from a ship to depths exceeding 70 m so that the operator could observe the sea bottom and pick up things of interest. Although Danilenko's hydrostat was used to investigate the remnants of the English steamship The Black Prince, which had been sunk during the Crimean War, and despite the fact that the entire operation was unsuccessful, this apparatus did demonstrate wide possibilities and was the first progenitor of a series of descendants.



The latter appeared in the thirties and the forties. Soviet constructors developed a whole series of interesting devices, including some designed for depths measured in kilometers. The latter applies to an unusual project for a self-propelled hydrostat which was completed in 1937 by a group of engineers headed by Yu. Shimanskiy and consulting academician A. Krylov.

Shimanskiy's two-seater, which externally looked like a vertical cylinder, was supposed to reach depths of 2.5 meters, move horizontally, hover above the bottom, and rotate around an axis. Another apparatus created by the engineer A. Maurer successfully passed its tests. The project was ended with a mobile submarine base designed by L. Beletskiy, which was a forerunner of the current "Prekotinents" and "Sadko". However, transformation of these plans into reality was interrupted by the war.

Nevertheless, by 1944 an emergency chamber, GKS-6, was lowered from a floating base ship; it was designed by A. Kaplanovskiy and safely reached a depth of 400 meters. It was this chamber that played a significant role in the history of our underwater research. In 1953 it was transferred to the Polar Institute of Fisheries and Oceanography [PINRO]. GKS-6 was placed aboard a research vessel, Persey-2, and used in almost 200 visits that scientists made to the fish. The ichthyologists immediately acquired a fondness for the hydrostat and for the new manner for investigating the inhabitants of the seas. Kaplanovskiy's idea were developed further and for seven years PINRO utilized the Sever-1 chamber. This chamber could reach 600 meters and at that depth the lights were turned on for observations on shoals of fish during different times of day and seasons of the year, with the results recorded on tape. Later, after the results of 600 submersions had been analyzed, the engineers created an autonomous minisubmarine, Sever-2, capable of conducting research at depths of 2500 meters from the surface.

Why did the scientists select a different apparatus? The bathyspheres had a serious shortcoming. Being connected by a cable to a base ship they moved in a horizontal plane with the same speed at which the base vessel was drifting because of winds and currents. This did not suit the scientists.

Consequently, the investigators of the deep required that the construction engineers built devices that would be light enough to be placed aboard trawlers but could still be used in studies on shoals of fish. And so the workers at the Klaypeda branch of Giprotybflot [sic], headed by A. Ryabchukov and V. Potapov, created Atlanta-1 in 1963. This was no longer a hydrostat but a bathyplane--a towed, two-seater, "underwater glider". When they entered commercial grounds the crew of the trawler Muksun lowered it to a depth of 1000 meters on a cable; once the ship started moving again the operator of the bathyplane used his controls to regulate the depth of submersion and maneuvered to stay above the trawling net in order to control it. Atlanta-1 was highly successful; this could be appreciated by simply observing the visitors to EXPO-67 who crowded around its model. Eight years later just as great an interest was shown in the towed bathyplane Atlanta-2 exhibited at the Interttybprom-75 exhibition. The latter could be submerged to an additional 200 meters and

the functions of the pilot and the experimenter were separated for the convenience of both. This apparatus was towed at a speed of six knots by Atlantik type of trawlers. The fact that the Atlanta's were successful is corroborated by the recent appearance of yet another bathyplane--Tetis.

But still, they lacked independence. Things stood differently with Severyanka, an ordinary diesel-electric submarine which, by decision of the Soviet government in 1957, was disarmed, outfitted with external lamps, various instruments, video systems, and transferred to the fisheries industry. Ten excursions by Severyanka proved to be a great "catch" and provided scientists with various information. However, this ship was constructed for different purposes and the number of those who wanted to visit the bottoms of the seas increased each year largely as a result of the interests of geologists, oilmen, and seismologists. They all preferred small submarines capable of great depths with maneuverability given preference over speed.

#### Minisubs for maxi-depths

After they had made a careful study of Soviet and foreign technology in this field, the workers at the Leningrad Institute of Giprotybflot undertook the construction of such apparatus. It was they who constructed a 305 ton submarine for the TINRO [Pacific Ocean Scientific Research Institute of Fisheries and Oceanography], which can dive to 300 meters and move at that depth with a speed of nine knots in any direction, stay put in one location, or land on the bottom. TINRO-1 is presently piloted by a pilot and a navigator, while the investigator studies the shoals of fish, observes the properties of sea water and its movements, ground structure, and carries out assigned programs. TINRO-1 also has a locking chamber through which an aquanaut can come and go at rather shallow depths, of course.

While this first product of the Leningrad workers was becoming accustomed to its tasks, the engineers were busy on a second apparatus designed for the Far East. And then, on November 12, 1974, captain Mikhail Girs closed the hatch on the tower of TINRO-2 and directed his ship under water. This minisubmarine was approximately six times shorter than its precursor, twice as narrow, and only 10 tons in weight. However, it operated freely at a depth of 400 meters (see *TEKHNIKA MOLODEZHI*, 1975, No 7).

In August of the following year trials began in the Baltic with an experimental underwater apparatus designated as OSA-3-600, constructed this time at the Moscow branch of Giprotybflot. It differed from TINRO and the Atlantas largely in its external manifestations, and in no way resembled a submarine boat. Its spherical steel body with four fin-like motors looked more like a "diving saucer" of Cousteau. Nevertheless, the maneuverability of OSA was exceptional and its working depth was 600 meters. On a first glance the submarine apparatus Argus, which was made at the Experimental Construction Bureau of Ocean Technology of the Institute of Oceanology imeni P. Shirshov of the Academy of Sciences USSR, was almost identical with the cable connected bathyspheres. Its round body contained life support systems, as well as control and communication systems, and room for three hydronauts. This "little ball" was capable of moving with a speed of three knots at a depth of 600 meters.

The reader must have undoubtedly noted that each new apparatus showed improvements and that the depth of submersion gradually increased. However, only the bathyscaphes--from the Greek for deep-sea ships--could traverse the kilometers that separate the surface from the bottom.

In 1959 the Leningrad branch of Giprotybflot was boiling with activity over B-5 and B-11 (the numbers indicate maximum depths in kilometers). The designers outfitted each apparatus with manual manipulators for capturing marine animals. In addition, the plans called for a crew of three. After six years the Leningraders presented plans for DSB-11--a bathyscaphe intended for studies on tectonic processes on the ocean's floor.

Thus, we have observed several trends in modern studies on the oceans of the world. In finishing our story we would like to conclude with the problem of life in the sea. Doesn't this show some similarity with conquest of outer space? The latter projects also began with a few short "jumps" in the thirties, followed by flights in small piloted space stations, and today we routinely receive reports from orbital space stations which function for months. Just about the same is now happening in Neptune's kingdom. No wonder that the words "cosmonaut" and "hydro-naut" are quite similar.

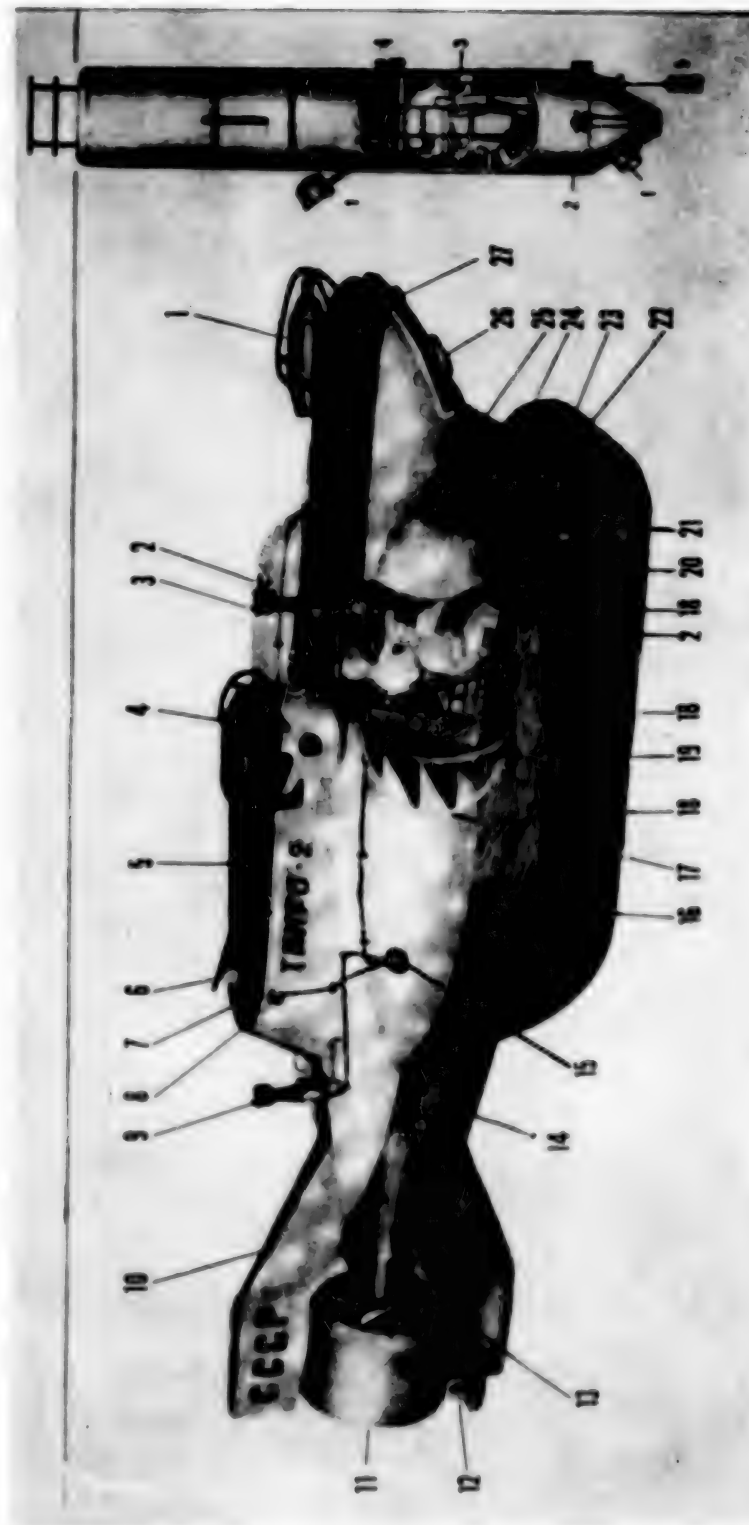
Simultaneously with the launching of the Soyuzes and Salyuts numerous underwater laboratories--Ikhtiandr, Sadko, Chernomor--are sent to the seabottoms. And then there is Bentos-300 which serves as the base of operation for 12 scientists and seamen who live for weeks on end among the residents of the deep. The Bentos-300 looks like a submarine, a trawler takes it to the place of submersion. This does not mean that the laboratory cannot move under its own power; it simply means that the scientists don't need greater speeds for covering the short distances of interest to them.

A great deal of interest is also attached to automatons that can almost independently gather information for oceanologists at depths of 300 meters. This represents another analogy with outer space.

#### An Ending but not an Epilogue

There are similarities between the apparatus that are sent out into space and into the ocean deep, and there are similarities between the professions of the respective investigators. And that is as it should be -- man is born on earth but he is destined to live and work in the as yet unexplored bodies of the solar system and in the mysterious depths of the receptive oceans of the world. Only the young enthusiasts can successfully apply their abilities and creativity here!

Fig. 1. TINRO-2 Out-away View



- Key:
1. Enclosed unit of sensors
  2. Jet motor for vertical mobility
  3. Arms
  4. Entrance hatch
  5. Antenna
  6. Lamps
  7. Lamps
  8. Emergency buoy
  9. Arms
  10. Vertical stabilizer
  11. Screw propeller
  12. Clearance light
  13. Horizontal stabilizer
  14. Machine section

15. Buoy
16. Sensors
17. Flange ballast tank
18. Battery Compartment
19. Solid hull
20. Illuminators
21. Rotating lamp
22. Illuminators
23. Illuminators
24. Illuminators
25. Illuminators
26. Lamps
27. Ground illumination system

- Key:
1. Lamp
  2. Battery compartment
  3. Investigator's cabin
  4. Screw propeller
  5. Guide rope and anchor

Fig. 2. Yu. Shimanskiy's deep sea hydrostat

Figure 3. Bathypplane Atlanta-1

Key:

1. Solid hull
2. Vertical rudder
3. Depth rudder
4. Submerging fin
5. Illuminators
6. Lamps
7. Cable

Figure 4. Towed Apparatus Tetis

Key:

1. Solid hull
2. Depth rudder
3. Submerging fin
4. Illuminators
5. Lamps
6. Cable

Figure 5. Autonomous apparatus Argus

Key:

1. Hull
2. Entrance hatch to the cabin
3. Screw propeller
4. Battery compartment





Fig. 6. Research Submarine Severyanka

Key:

1. Projector
2. Telemonitor
3. Lamps and long distance light projector
4. Conning tower
5. Periscopes
6. Snorkel
7. Screw propeller
8. Sonar
9. Scientific compartment



Fig. 7. Experimental habitable apparatus OSA-3-600

Key:

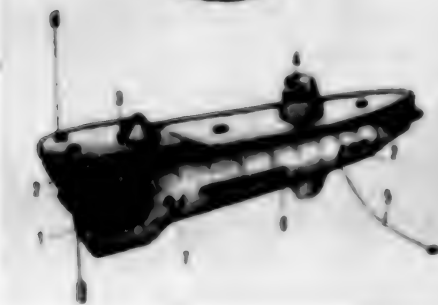
1. Hull
2. Fin-like motors
3. Scientific compartment
4. Lamps
5. Illuminators
6. Landing apparatus
7. Motor guard



Fig. 8. Underwater Laboratory Bontos-300

Key:

1. Lamps
2. Illuminators
3. Conning tower
4. Guide rope and anchor
5. Lock chamber for aquanauts
6. Side projector



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## ONCOLOGY

### USSR CANCER RESEARCH PROSPECTS DISCUSSED

Moscow TRUD in Russian 24 May 1979 p 3

[Interview with Nikolay Nikolayevich Blokhin, president of the USSR Academy of Medical Sciences, general director of the Oncological Research Center, and hero of socialist labor, by Special Correspondent of TRUD I. Melenevskiy: "Prompt Diagnosis Needed: Medicine and Life"]

[Text] In recent years scientists and medical practitioners have been concentrating their effort on the struggle against malignant tumors. The prospects for the cure of cancer and the methods of combatting this horrible affliction are described on the request of the special correspondent of TRUD I. Melenevskiy by the President of the USSR Academy of Medical Sciences, General Director of the Oncological Research Center, Hero of Socialist Labor Nikolay Nikolayevich Blokhin.

[Question] A part of the public believe that medicine is helpless and powerless when it comes to the cure of an affliction like cancer. What are the present-day advances in the treatment of malignant tumors? Can it be said for example that the current mortality rate due to cancer is lower than it had been 20 years ago?

[Answer] Cancer in the early stages is in most cases a curable disease. The widespread opinion of its fatality is simply wrong. Yes, at present many people die of cancer. But most often this happens when we are dealing with its neglected form, when the malignant tumor had not been detected in time.

Why then cannot cancer be diagnosed in time? It is a wily disease. It invades the organism stealthily and imperceptibly. In the early stages the symptoms of the newly appearing malignant tumor are not so easy to detect, not even by the stricken individuals themselves.

In this country we are waging a broad program of measures for early detection of tumors. They are early preventive care and outpatient treatment. Considering that many tumors in the early stages do not produce readily

noticed symptoms, the dissemination of awareness among the public on the need to be medically examined in the event of appearance of the least symptoms of this disease is of great importance.

Is the cancer mortality rate at present lower than 20 years ago? You see, this is not a properly worded question.

The morbidity rate due to cancer at present is higher than it had been several tens of years previously, and that is principally because of the demographic changes--the increase in the number of the elderly and aged. Cancer basically is a disease of old age. That is why, e.g. in pre-Revolutionary Russia, many people did not live long enough, so to speak, to be able to be stricken by cancer, since the average lifespan at the time had been short. At the same time, at present, of course it is possible to cure a larger number of stricken individuals than it had been in the past. In recent years the mortality rate due to cancer in this country has not been rising: its indicators have become stabilized.

[Question] You said that many forms of tumors are being treated successfully. Could you please discuss this in more detail?

[Answer] I already said that the curability of cancer is directly dependent on its stage. That is, the earlier cancer is detected, the more chances for its cure. Much depends on the location of the tumor. Say, it is a surface tumor and so is detected more rapidly, and is treated more easily. These days, e.g. virtually no one dies of skin cancer or of cancer of the lower lip. But as for cancer of the alimentary tract, of lung, of stomach and particularly of the pancreas, that is much more difficult to identify in time.

Oncology has scored major advances in the treatment of one of the malignant tumors--chorioepithelioma of the uterus, which usually strikes young women.

In this connection, we not only restore health to women, but preserve their ability to bear children. About a hundred of such children are under observation at our Center. They are healthy and sturdy, although they were born of mothers whose life not so long ago had been in the balance.

Cancer is no single disease but rather a large group of diseases. And there does not exist a universal drug for control of them all. Different means and techniques of treatment are devised for different tumors. This includes combinations of surgery, radiation therapy and chemical therapy, and combined drug treatment as well. All these methods are tailored by physicians to fit the individual patient.

I do not wish to go more into this topic. After all, this is not a classroom or a professional discussion. Let me only add that quite a few new effective methods for cancer treatment have recently been developed so that health and the ability to work could be restored to thousands of people.

[Question] There exists various viewpoints on the causes of malignant tumors. What advances have been made by science in understanding these causes.

[Answer] Scientists at present know a lot about factors in the development of tumors. So much is known, in fact, that laboratory researchers can artificially induce tumors in animals as desired in order to investigate various problems. Following a previous plan, cancer of the skin, of liver, various tumors of the gastrointestinal tract and osteosarcomas can be induced in laboratory animals.

We are thus familiar with factors contributing to the formation of specific types of tumors. They are various carcinogens, as well as viruses which indubitably induce a number of tumors in animals. But this knowledge does not mean that we can say that exactly the same factors induce cancer in man, if only because similar experiments have not, of course, been performed on humans.

At present we strive to investigate various factors inducing cancer in man. To this end, epidemiological studies of the specific features of the propagation of various tumors in various natural zones in this country are under way. The purpose of these studies is to identify the factors contributing to the appearance of particular types of cancer in particular zones. In this connection, the customs, habits, dietary features and living and working conditions of people are investigated.

Interesting research into the role of viruses in the occurrence of human leukosis is being done in Sukhumi at the Institute of Experimental Pathology and Therapy. Several years ago Moscow received from that institute monkeys which were here administered filtrates of blood from persons stricken with leukoses. Thereupon the animals were returned to Sukhumi and 1-1/2 to 2 years later developed leukosis-like diseases. In a way the course of their illness duplicated the pattern of human leukosis, but there also existed definite differences.

A virus has been isolated from the blood of the ill animals. This virus is now being investigated not only by Soviet virologists but also, in accordance with the program for Soviet-American cooperation in oncology, with the participation of American virologists. However, this project still has not been completed and the question of the viral nature of human leukosis is still under investigation.

[Question] What are the organizational principles of oncological service in this country? What role is played in that service by the Center you direct?

[Answer] In this country there exists a network of about 250 oncological examination centers--special institutions concerned with the detection and treatment of malignant tumors. As a rule, they include in-patient and

polyclinic departments. These centers contain all the facilities for surgical, radiation and therapeutic treatment of cancer diseases and keep records of cured patients in their regions, and keep these cases under continuing observation. In addition, many regular hospitals maintain oncology departments.

In each republic there exists a methodological center directing work on all aspects of oncology. Such centers are specialized institutes with extensive medical facilities. The medical institution overseeing all this network is the Leningrad Institute of Oncology named N. N. Petrov.

The Oncological Research Center is the sole and largest institution of its kind within the USSR Academy of Medical Sciences. Its purpose is to coordinate and plan scientific research into malignant tumors in this country. The Center employs a staff of competent scientists and has the necessary facilities for research work. Many of the world's major oncologists who have visited the Center have praised most highly the conditions provided here for scientific research.

[Question] What new anti-tumor drugs have appeared recently?

[Answer] You cannot expect me to name a miracle drug that cures all kinds of tumors. There is not and most likely there never will be such a cure-all. We have a joint program for cooperation with United States oncologists in problems of tumor chemotherapy. We have transmitted to America more than a hundred drugs developed in this country. And they in their turn sent us quite a few drugs for verification. But this does not mean that all these drugs will prove satisfactory and suitable for practical use. At present the oncologist's arsenal includes about 40 drugs that have proved themselves in the treatment of various kinds of tumors.

[Question] In your opinion, when will cancer finally be conquered?

[Answer] To me this question sounds somewhat strange. Let me repeat. The term "cancer" refers to a large number of tumoral diseases. There exist types of tumors in whose treatment physicians have achieved complete success. Thus, it is incorrect to speak of cancer as a whole as an incurable disease. In this country at present there are about two million people who have been cured of cancer. One-half million of these are persons who had regained their health ten and more years ago.

Our knowledge of cancer is steadily growing. And methods for combatting it are becoming increasingly effective. But to say that some day, in some particular year, cancer will disappear would be a speculative, unscientific assertion. I believe that in the 21st century cancer will remain a problem, perhaps less severe than now but still sufficiently serious.



## EVALUATION OF HEAT FLOW COMPONENTS FROM HEATER TO SKIN IN AN ELECTRIC THERMAL SUIT

Kiev DOPOVIDI AKADEMIYI NAUK UKRAYINS'KOYI RSR in Ukrainian No 4, 1979  
pp 294-297

[Article by I.M. Naumenko, Institute of Materials Science, Academy of Sciences Ukrainian SSR, Kiev]

[Text] Heaters constitute one of the most important features in designing thermal suits since they determine the efficiency at which the storage cells operate. An important aspects of this problem centers around the nature of heat transfer from the heater to the human body. A study of the heat flow components is also of biological significance: information is available which suggests that prolonged exposure to low intensity radiant heat promotes an increase in the adenine nucleotides (ATP, ADP, AMP) [1].

Total heat flow from a unit surface area of a heater is given by the following relationship:

$$q_T = q_{\text{cond}} + q_{\text{rad}} + q_{\text{conv}}, \quad (1)$$

where  $q_T$  is the total heat flow,  $q_{\text{cond}}$  is conductive flow,  $q_{\text{rad}}$  is radiant heat flow, and  $q_{\text{conv}}$  represents convective heat flow.

According to Fourier's law, conductive heat flow is expressed by (2):

$$q_{\text{cond}} = \frac{\lambda(t_n - t_s)}{\delta}, \quad (2)$$

where  $\lambda$  is the coefficient of heat transfer through a layer,  $t_n$  is the temperature of the heater,  $t_s$  is the skin temperature, and  $\delta$  represents the average width of the air layer between the heater and the skin.

The transfer of radiant heat is derived from the theoretical fundamentals underlying the mechanism of heat energy flow [3]:

$$q_{\text{rad}} = a_{\text{rad}}(t_n - t_s), \quad (3)$$

$$a_{\text{rad}} = \varepsilon \cdot \phi \cdot f(t_n, t_s), \quad (4)$$

$$f(t_n, t_s) \approx 5,67 \frac{\left(\frac{t_n + 273}{100}\right)^4 + \left(\frac{t_s + 273}{100}\right)^4}{t_n - t_s}, \quad (5)$$

where  $\alpha_{\text{rad}}$  is the coefficient of heat transfer by radiation,  $\epsilon$  is the degree of surface blackness,  $\phi$  is the radiation coefficient of the system, and  $f(t_n, t_s)$  is a surface temperature dependent function

Evaluation of heat flows is based on  $t_n = 42^\circ\text{C}$ ,  $t_s = 32^\circ\text{C}$ , 1 mm thickness of undergarments ( $\delta_u$ ), 0.5 mm thick satin lining of the electric heater ( $\delta_s$ ), and an air layer of 0.5 mm ( $\delta_a$ ), i.e.,  $\delta = 2 \text{ mm} = 2 \times 10^{-3} \text{ m}$ .

$$\lambda_1 = f(\lambda_a, \delta_a, \lambda_s, \delta_s, \lambda_u, \delta_u) \quad (6)$$

The coefficient of heat conductivity of air is selected at average value of the temperature of the layer  $t_{\text{av}} = 0.5 (t_n + t_s) = 37^\circ\text{C}$ .

At  $t_{\text{av}} = 37^\circ\text{C}$ ,  $\lambda_a$  is  $2.7 \times 10^{-2} \text{ W/m}\cdot\text{degree}$  [4].

The effective heat transfer from the heater unit oriented perpendicularly to the flow of current can be calculated from the formula given by Dul'nev and Zarichnyak [2]:

$$\frac{1}{\lambda_1} = \frac{\delta_u + \delta_s}{(\delta_u + \delta_s + \delta_a) \lambda_{\text{tis}}} + \frac{\delta_a}{(\delta_u + \delta_s + \delta_a) \lambda_a}, \quad (7)$$

$$\frac{1}{\lambda_1} = 28, \quad \lambda_1 = 3,6 \cdot 10^{-2} \text{ W/m}\cdot\text{degree}$$

The resultant thermal current can be calculated from formula (1), modified as follows:

or in:

$$q_1 = -\frac{\lambda}{\delta} (t_n - t_s) + \alpha_{\text{rad}} (t_n - t_s) + \alpha_{\text{conv}} (t_n - t_s). \quad (8)$$

The coefficient of conductive heat transfer can be determined from:

$$\alpha_{\text{cond}} = \frac{\lambda_1}{\delta} \quad (9)$$

$$\alpha_{\text{cond}} = 18 \text{ W/m}^2 \cdot \text{degree}.$$

Since the degree of blackness ( $\epsilon$ ) and the coefficient of irradiation of the system ( $\phi$ ) are approximately 1, we can determine the coefficient of radiant heat transfer to be approximately  $6.7 \text{ W/m}^2 \cdot \text{degree}$  according to Dul'nev and Semyashkin [3].

The convective component in our calculations is equal to zero since, according to Chudnovskiy [5], in 5 mm thick layers there is no convection until temperature differences reach 100 degrees. Therefore,  $q = 24.7 \text{ W/m}^2 \cdot \text{degree}$ .

It can be calculated that the mechanism of convection accounted for 70% of the heat flow from the heater to the surface of the skin across a 2 mm air space. However, when we take into consideration that 3/4th of this space is taken up by layers of cloth (0.5 mm satin lining, 1 mm undergarments), the fraction of the radiant heat will be much smaller than the calculated 30%, i.e., the dominant factor will be heat transfer by conduction.

In this situation, due to a decrease in the temperature gradient between the heater and the skin, the temperature of the heating device can become a powerful external stimulant to the body and elicit reflex responses, particularly vascular responses. Consequently, in order to diminish heat loss into the environment, certain calculations were performed to select optimum temperatures on the heating device.

According to Newton's law, the extent of heat loss to the environment can be calculated from the following formula:

$$Q = (1/R_T) \cdot \Delta t \cdot S. \quad (10)$$

It follows then, that when the heat resistance of the suit ( $R_T$ ) and the area of heat loss ( $S$ ) are constant, the extent of heat loss can be decreased by decreasing the temperature difference ( $\Delta t$ ) between the heater and the environment. Thus, for example, if the difference between the temperature of the heater ( $t_h = 42^\circ\text{C}$ ) and that of the surrounding air ( $t_a = -10^\circ\text{C}$ ) is  $52^\circ\text{C}$ , then by decreasing the temperature of the heater to  $+32^\circ\text{C}$  the difference decreases to  $42^\circ\text{C}$ , i.e., a decrease of 20%. According to the laws of thermodynamics, this difference also represents the decrease in heat loss to the environment.

The decrease in the intensity of heat flow can also be justified from the physiological viewpoint: by lowering the temperature of the heater the probability of a reflex effect from the thermal suit on the human organism is diminished. It has been established that under the influence of a fairly strong thermal stimulus a generalized vascular response occurs [6,7]; the latter consists of vasodilatation which in turn leads to loss of body heat.

The calculations which have been performed indicate that conduction is the main mechanism by which heat is transferred in a thermal suit. In order to prevent a reflex effect on the human organism and to minimize heat loss to the environment it is necessary to decrease the temperature of the heater without diminishing the overall intensity of thermal heating.

Despite the insignificant amount of radiant energy in the thermal flow, the possible elevation of adenine nucleotides must be considered and deserves further experimental investigation on the basis of the findings reported in the literature [1, 8-10].

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Ukrayins'koyi RSR",  
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## SCIENTISTS AND SCIENTIFIC ORGANIZATIONS

SESSION OF GENERAL MEETING OF THE DEPARTMENT OF GENERAL BIOLOGY, USSR ACADEMY OF SCIENCES, DEALING WITH 'GENERAL BIOLOGY TO SERVE AGRICULTURE'

Moscow ZHURNAL OBSHCHEY BIOLOGII in Russian No 2, 1979 pp 313-316

[Article by T. N. Shcherbinovskaya]

[Text] The session of the General Meeting of the Department of General Biology, USSR AS [Academy of Sciences] dealing with "General Biology to Serve Agriculture" convened in Moscow on 4 and 5 December 1978.

On 4 December, in his opening remarks at the session, Academician Secretary of the Department M. S. Gilyarov observed that our Communist Party is consistently devoting enormous attention to agriculture problems, as attested to by the decisions of the 25th CPSU Congress, the July and November (1978) plenums of the CC CPSU and speeches of comrade L. I. Brezhnev. Since agricultural production is the production of biological objects, it is, of course, based on biological data and information accumulated by human practice over many thousands of years. This places great obligations on biologists, to direct their efforts toward basic problems that could benefit agricultural science and agricultural practice. These problems are referable to productivity, biological production, anthropogenic changes in biocenoses and agroecosystems, migrations and behavior of harmful and useful species, integrated control of pests and diseases of agricultural crops, and investigation of the patterns of individual development of organisms. Genetics and breeding are faced with major tasks: not to duplicate the work done by sectorial institutions, but to search for new principles. There are also major tasks pertaining to maintaining the fertility of soil, preservation and improvement of the entire diversity of organisms that produce soil, finding effective methods of using fertilizers, etc.

Our party and the entire nation are entitled to expect biologists to make their contribution to the cause of augmenting the productivity of agriculture, growth of which is a guarantee for the building of communism.

The paper of Academician N. P. Dubinin, entitled "Genetics to Serve Selection," dealt with the history of genetics and selection [breeding] in our country, based on the activities of the greatest scientists, N. I. Vavilov, I. V.

Michurin, A. S. Serebrovskiy, P. P. Luk'yanenko, V. S. Pustovoyt and others. Use of the basic achievements of modern genetics plays a large role in advances of selection. This refers to the advances in experimental polyploidy applied to develop triploid heterosis hybrids of sugar beets and potatoes, genetically controlled heterosis as the basis of new advances in raising sunflowers, modal selection in working with the cotton plant, radiation mutagenesis in development of winter wheat varieties, polyploidy and hybridization in yeast selection, attenuated mutants and protection of vegetable crops in the closed soil, modern approaches to selection of breeds and strains that conform with the requirements of industrial livestock farming, inbreeding and methods of zygote microsurgery.

N. P. Dubinin described the specific research that is being pursued at the Institute of General Genetics, USSR AS, which he heads; it deals with agricultural practice, in particular, development of methods of producing animal breeds and plant varieties best adapted to the methods of practicing agriculture in the form of agroindustrial and livestock complexes.

Academician V. N. Remeslo delivered a paper entitled "Wheat Selection to Serve Production." He observed that the decisions of the July plenum of the CC CPSU were a major event in the life of our people. Implementing the system of effective measures of the Communist Party, agricultural scientific and production workers have made great advances in the past few years with respect to increasing grain production and sales to the state; but we must raise even more grain. It is possible to augment radically the mean yield of grain crops on the basis of increased sophistication of agriculture and introduction of new, intensive varieties of winter wheat. V. N. Remeslo described the work being done in this direction, under his supervision, in the Ukraine and particularly the Mironovskiy Breeding Station, which was begun as far back as 1949.

As a result of many years of purposeful research on the patterns of inheritance of economically valuable features, such as winter hardiness, productivity, etc., a new variety of winter wheat of the intensive type was developed, Mironovskaya 264, and later on Mironovskaya 808, which is superior to the former in harvest and a masterpiece of Soviet and worldwide breeding. It is very flexible and widespread in the most diverse regions of the USSR and foreign countries. Other varieties were also developed: Yubileynaya, Il'ichevka, Mironovskaya Yubileynaya and others. Four new varieties of winter wheat are presently undergoing extensive testing at kolkhozes and sovkhozes. All of the newly developed winter wheat varieties are highly productive, hardy and have a good quality of grain. Work is in progress to develop spring wheat cultivars.

B. A. Neunyllov, corresponding member of the USSR AS, reported on the biological bases of rice planting in the Far East. Rice is the main food for more than half the people on earth. At the present time, there are more than 20,000 varieties of rice. In our country, there are good conditions for cultivating this crop in the Far East, where it occupies large areas. The pressing biological tasks include development of very early maturing varieties of

rice with increased resistance to low temperatures at the critical periods and the search for methods of forcing processes of organogenesis at low ambient temperature by treating the physiological and biochemical functions of the plant and regulating nutrition thereof; improvement of microclimate of rice fields, selection and evaluation of land masses that are best suitable for rice growing, development of special designs of irrigation maps for rice fields in the most northerly regions, questions of technology of rice growing and concomitant crops in crop rotation of northern region, integrated system of protection against weeds, diseases and pests.

The paper of Academician Ye. M. Lavrenko, T. I. Isachenko and S. A. Gribovaya (delivered by S. A. Gribovaya) dealt with current maps of vegetation and their importance to agriculture. Depending on their scale, geobotanical maps can be used for national planning in the preparation of systems for wise use of land and vegetation resources of our country, as well as for implementation of current management measures at kolkhozes and sovkhozes. Geobotanical maps may be needed to solve the most diverse practical problems, including evaluation of ecological conditions, grading of soil occupied by spontaneous vegetation, in reclamation of new territories, amelioration, planning of the use and reconstruction of agricultural production and protection of the plant kingdom. This paper was illustrated with well-made geobotanical maps of European USSR, Belorussia, Northern Kazakhstan, etc.

On 5 December, the first paper at the morning session was delivered by K. M. Ryzhikov, corresponding member of the USSR AS; it dealt with the scientific bases of prevention of helminthiasis in farm animals. He demonstrated the close link between helminthology and agriculture. The research of Soviet helminthologists is directed toward solving general biological, veterinary and medical problems. The biological problems include the study of the species composition of helminths, their geographic distribution, morphological and taxonomic distinctions, ecology, physiology and biochemistry. The results of these studies became in essence the basis of all practical measures for the control of helminths and protection of farm animals against them. Such measures are being actively implemented in all Union republics. Extensive research is in progress in the laboratory of helminthology, USSR AS, which is directly related to the demands of the animal industry: identification of life cycles of pathogens of parabronematoses, stephanofilariosis, neoascariasis of cattle, helminthiasis of domestic fowl, as well as studies dealing with the biological distinctions of livestock helminths in different parts of our country.

K. M. Ryzhikov commented on the outstanding achievements of K. I. Skryabin with respect to development of Soviet helminthology and measures for the control of helminths in virtually the entire nation.

The paper of M. V. Gorlenko, corresponding member of the USSR AS, dealt with the status and prospects of the biological method of protecting plants against diseases. The question of biological protection against plant diseases is a diversified one, and it consists of using antagonist microbes and secondary

parasites or products of their vital functions to suppress infectious diseases of plants. Several agents have been developed to control bacteriosis of grain and leguminous crops, powdery mildew fungi and bacteriosis of tomatoes. Research is in progress of the changes in biocenoses in the direction of depression of soil pathogens. Work must be intensified on genetics of producers; the search should be continued for new antagonists; the study of cross-protection of plants should be expanded, i.e., making plants insusceptible to diseases by means of primary inoculation (vaccination) with nonpathogenic microbes or mildly pathogenic strains of pathogenic ones. This method is already being used with success to control tobacco mosaic virus in hothouse tomatoes.

Ye. S. Sugonyayev, candidate of biological sciences (Zoological Institute of the USSR AS) reported on experience in developing an integrated system of protecting the cotton plant from pests on a biocenological basis. In agrobiocenoses, the correlations between phytophages and their natural enemies, zoophages, are simpler and shorter than in natural ones, as a result of which there is attenuation of the role of feed relations between them with increase in food resources for phytophages and this causes them to multiply on a mass scale. As a result, more toxic chemicals have to be used against the harmful species. However, this has its adverse aspects and, as a result of comprehensive investigation of this problem, a new direction in plant protection was conceived, the biocenological direction, whose task it is to develop systems for the control of populations of harmful and useful species (integrated systems). Ye. S. Sugonyayev demonstrated the application of such a method on the example of the cotton fields in Tadzhikistan and Turkmenia, with exceptionally good results: increased cotton harvest and decreased contamination of fields by pesticides.

A paper entitled "Theoretical Bases for the Control of Avian Coccidiosis and Introduction of Scientific Advances to Industrial Poultry Farming" was delivered by M. V. Krylov, doctor of biological sciences (Zoological Institute, USSR AS). In view of the serious detriment caused by coccidia to agriculture, the problem of controlling these parasites is very important. Some serious research has been done on the metabolic interactions between parasites and the host organism and the biochemical changes in the host induced by parasitizing coccidia. Thus, these parasites induce changes in metabolism of proteins, nucleic acids, trace elements, etc. Several theoretical substantiations have been worked out for the use of pathogenetic therapy and selective synthesis of inhibitors of metabolic processes of parasites. Some of these data have already found practical application; several products are being used for the treatment of toxoplasmosis, immunochemoprophylaxis of coccidiosis, and this yields a substantial economic effect.

The evening meeting on 5 December began with a paper by Academician M. S. Gilyarov, entitled "Biological Methods for Increasing Soil Fertility." After commenting on the outstanding role of Soviet scientists in the study of the role of living organisms in soil-forming processes and maintenance of soil fertility, this speaker dwelled on several methods related to the use of biological agents to increase soil fertility. For example, the functions of



earthworms are a potent factor in this regard. M. S. Gilyarov described in detail the taxonomic and ecological aspects of this group of invertebrates. Numerous experiments demonstrated the effectiveness of artificial introduction of specific species and ecological groups of worms in areas where these species are not encountered for historical reasons, but where they can exist according to ecological conditions. One also has to take into consideration the assortment of fertilizers used, since some of them have a devastating effect on earthworms. Treatment of field soil, particularly, nonchernozem, with specially composted organic fertilizers of different origin at the decomposition stages, when useful invertebrate soil-producers multiply in them and accelerate mineralization and humification of plant residue, which aids in aeration, drainage and soil structure-formation, is another direction of research on biological improvement of soil.

Finally, the method of processing manure with the use of fly larvae, both for obtaining composts and providing pig farms with valuable protein feed, which is being developed in Novosibirsk, is of definite promise for large livestock (primarily swine) farms.

All these studies, which represent really new approaches to "biological improvement of soil," should undergo appropriate development for the purpose of broader introduction of their results to practice.

The paper of S. D. Erpert, candidate of agricultural sciences (laboratory of forest science, USSR AS), entitled "The Effect of Forestation on Productivity of Agricultural Crops" (delivered by I. N. Olovyanikova) discussed the set of measures used to increase the yield of agricultural crops in the semidesert regions of the northern Caspian area, according to the findings of a team of workers at the Dzhanybekskiy Base which was founded in 1950. The arid climate there and salinity of soil make it difficult to develop for agriculture. This base was faced with the task of working out the scientific fundamentals for agricultural development of the semidesert complex of the intervalley plain under dry farming conditions. The results of many years of studies of development, plowing of solonchaks [alkali soil], various methods of retaining snow and, in particular, the use of windbreaks, etc., made it possible for this base to develop a system of ameliorating the soil of the semidesert complex for agricultural use. The specific measures were illustrated with tables.

A paper entitled "Botany in the Service of Agriculture," was delivered by R. V. Kamelin, doctor of biological sciences (Botanical Institute, USSR AS). He indicated that all branches of botanical science have a direct application to agricultural practice and it is, in essence, the basis of scientific plant growing. The following are the most important problems of botany with direct application to agriculture: anthropogenic destruction of the plant cover, the problem of new crops (feed plants, development of man-made hay fields and pastures, new industrial crops, etc.), enlarging the natural feed base, complex natural zoning (wise assignment of locations for different types of crops) and protection of the plant kingdom.



The general meeting adopted a decree, in which complete approval is given to the decisions of the July (1978) plenum of the CC CPSU concerning continued development of agriculture, the main directions of research are defined, in particular, the study of plant and animal biology in order to increase their productivity, development of methods of breeding new varieties of plants and highly productive breeds of animals, expansion of work dealing with ecology, biological methods of integrated protection of plants and animals against pests and parasites, biological methods of increasing soil fertility, preparation of forecasts of changes in the natural environment under the influence of anthropogenic factors, etc. It was noted that there is a need to further develop joint research to be pursued with institutions of the All-Union Academy of Agriculture imeni V. I. Lenin [VASKhNIL] and USSR Ministry of Agriculture.

The Office of the Department of General Biology was asked to regularly examine at its meetings the progress of joint work dealing with agrarian problems performed by institutions of this department and VASKhNIL.

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## SCIENTISTS AND SCIENTIFIC ORGANIZATIONS

### INTERNATIONAL SCHOOL OF 'MATHEMATICAL MODELING OF BIOGEOCENOTIC PROCESSES'

Moscow ZHURNAL OBSHCHEY BIOLOGII in Russian No 2, 1979 pp 316-318

[Article by V. V. Galitskiy and A. S. Komarov]

[Text] An international school of "mathematical modeling of biogeocenotic processes" convened in Pushchino (Moscow Oblast) from 2 to 10 August 1978, within the framework of the CEMA III project.

About 70 specialists from 4 countries (PRB [People's Republic of Bulgaria], GDR, USSR and CSSR) participated in the work of the school.

The syllabus [program] of the school consisted of the following: methodological and technical problems of modeling biogeocenotic objects; models of plant growth and bioproduction models of plant communities; analysis and modeling of spatial structure of biogeocenotic objects; analysis and modeling of some physicochemical, biological processes and transfer processes in soil.

V. A. Kovda, chairman of the organizing committee delivered the opening remarks.

The lecture of N. I. Bazilevich (USSR), entitled "Hierarchic Conceptual Balance Models of Ecosystems and Soil," described models of exchange processes in ecosystems of forests, steppes and deserts. The rates of evolution of ecosystem were evaluated on the basis of the uncompensated intensity of input and output flows. In particular, grassy ecosystems were found to be the fastest.

The paper of M. Palat (CSSR) discussed different approaches to modeling forest ecosystems, as well as the work being done at the Institute of Forest Ecology in Brno on modeling of the cycle of nutrients, distribution of biotic and abiotic elements, and accumulation of biomass in ecosystems of floodplain forests.

O. G. Chertov, V. M. Prokhorov and O. M. Kvetnaya (USSR) proposed a quantitative model of the cycle of nitrogen in forest biogeocenoses, which was used to simulate various agricultural procedures.

The lecture of R. Y. Florov (PZB), entitled "Thermodynamic Model of a Forest Ecosystem," formulated a variant of a holistic quantitative approach to analysis of ecosystem function with unimpaired natural cycle of matter. With reference to photosynthesizing and mineralizing subsystems of a forest ecosystem as open thermodynamic systems, and evaluating the energy flows in these subsystems, the speaker demonstrated that the rates of the principal processes in these subsystems are quantitatively similar in the case of growth of the main timber variety in its natural range. Under other conditions, the timber species makes inefficient use of the production potential of its locale.

L. B. Pachepskaya (USSR) reported, on the basis of the balance [pulp?] method, on an attempt to develop a model of a soil-plant system in order to determine the link between productivity of an agrocenosis and structure of redistribution of energy among elements of this system during the vegetation period.

The paper of M. V. Pridin (USSR) discussed the prerequisites for modeling microevolution of forest-producers of western Caucasus against the background of anthropogenic factors. He reported the importance of taking into consideration the spatial heterogeneity of populations and communities.

The paper of N. V. Glotov, A. A. Krylov and L. F. Semerikov (USSR) dealt with computer analysis of a model of spatial genotypic structure of a population of sessile oak. The spatial simulation model of the dynamics of genotypes makes it possible to investigate the genetic and ecological structures of populations in a series of generations.

The paper of A. S. Komarov (USSR) described methods and results of analysis of the dynamics of horizontal structure of pure timber stands of the same age, with the use of a computer. It was demonstrated that the horizontal structure of timber stands is largely determined by the intraspecific correlations between trees, which are also reflected in the dynamics of weight characteristics. In particular, it was found that the structure of tree distribution according to diameter changes in a rather complex manner with age.

The lecture of S. M. Razumovskiy and L. B. Rybalov (USSR), entitled "The Main Patterns of Succession Dynamics of Biocenoses," formulated the conception of self-regulatory system of vegetation in a floristically homogeneous region, similar in its basic tenets to the succession theory of Clements. It was noted that there is replacement of complexes of soil invertebrates with succession changes in vegetation.

Ye. V. Gordeyeva (USSR) submitted the results of investigation of complexes of soil microfauna as related to succession changes in vegetation; the changes in the complexes can be characterized as a change in the measure of Shannon, which is known from information theory. During succession there is monotonous increase in Shannon's measure, which reaches a maximum in a climax community.

The lecture of V. V. Galitskiy (USSR), entitled "Basic Concepts of Biogeocenology and Modeling of Biogeocenotic Objects," formulated the principle of "minimal angle of vision," as a methodological base for expounding theory of biogeocenotic objects and series of "insertion" models of these objects. He discussed the definition of biogeocenosis (BCC) offered by V. N. Sukachev and formulated variants of constructive definition of BCC.

The lecture of A. A. Nichiporovich concentrated mainly on the "ideal model" of a crop as a photosynthesizing system, determination of the influence of parameters of photosynthetic and physiological activity on the harvest. The lecture of O. A. Sirotenko and V. A. Gorbachev (USSR) discussed the construction and operation of complex models of the production process in agroecosystems. I. I. Sudnitsyn (USSR) made a distinction between two main tendencies in modeling migration of soil moisture as plants consume water: empirical-statistical and functional-physical.

The lecture of Ya. A. Pachepskiy, A. A. Ponizovskiy, Ye. G. Morgun and D. P. Meleshko (USSR) dealt with modeling of salt exchange between soil phases. They demonstrated the role of dimensionality theory in obtaining empirical equations. They discussed the properties and applicability of the equilibrium model in a soil salt system to the description of salt migration in soil.

The paper of V. M. Prokhorov and O. N. Kvetnaya (USSR) dealt with modeling of the dynamics of forms of phosphorus in soil. An example of the use of mathematical models for predicting water and salt conditions of soil in the operating period was given in the paper of K. Z. Azizov and F. D. Mikhailov.

The lecture of Ya. A. Pachepskiy, Ye. G. Morgun, L. B. Pachepskaya and Ye. V. Mironenko (USSR) discussed quantitative forecasting of changes in soil and hydrogeological components of agroecosystems as related to water reclamation. The paper of A. S. Isayev, R. G. Khlebopros and L. V. Nedorezov (USSR) describes a model of interaction between phytophage and entomophage populations on the basis of the principles of phenomenological theory and experimental data. This model permits classification of spurts of increase in number of forest insects and determination of the conditions that lead to such spurts, as well as to single out the typical points in the system, passage through which determines qualitative changes in population dynamics. A dynamic model of microbiological conversions of organic matter in soil for two levels of details was described in the paper of I. F. Bondarenko, O. S. Zhuravlev and I. A. Shvytov (USSR).

I. A. Poletayev (USSR) delivered a lecture that offered mathematical substantiation of the known "generalized growth formula," on the example of a model of a higher plant. The measured parameter of the plant as a function of time is similar to the formula of Shmal'gauzen, and it is justified by its elementary structure. The lecture of T. Frey (USSR), entitled "Growth as an Autocatalytic Information Process," discussed the demonstration of

certain formal analogies to information theory, which occurred in problems of modeling plant growth.

V. V. Galitskiy (USSR) delivered a lecture, entitled "Modeling of the Production Process in a Plant Community," in which he formulated an approach to modeling of the dynamics of plant biomass and competitive processes in a plant community using the principle of "minimal angle of vision." It was concluded that it is important to consider the horizontal structure of a plant community in analysis of its function.

The lecture of G. Stoeker (GDR) dealt with applications of multidimensional variance and discrimination analysis for quantitative estimation of changes in ecosystems resulting from their development and environmental changes, for the purpose of evaluating spatial and time-related differentiation of ecosystems. He discussed questions of singling out diagnostic signs that are required for the classification of states, choice of classification steps, use of cluster analysis, etc.

K. Steinmüller (GDR) discussed the procedure for demonstrating ecological niches in a system of populations (compartments) with a specific arrangement of intervals of existence. It was shown that, with the exception of those that are the best adapted, all populations occupy niches consisting of two symmetrical domains in the space of environmental parameters.

The lecture of E. Matthaus (GDR) dealt with the influence of extensive and intensive environmental factors on growth of interacting populations and the ecosystem as a whole. A good consistency was obtained between the results of modeling the growth of *Stellaria media* weeds and the experimental data on ground cover.

Two scientific excursions were organized for the participants at this school. The composition of local flora and fauna was demonstrated at the Prioksko-Terrasnyy Preserve. S. M. Razumovskiy demonstrated and explained examples of succession changes in vegetation. Modern computer technology, used to model biogeocenotic objects, as well as the system of programs for statistical processing of experimental data, etc., were demonstrated in operation.

At the final meeting, a decision was adopted, in particular, to recommend that such schools convene regularly; organizational measures were proposed to coordinate work dealing with mathematical modeling within the framework of the CEMA III project; it was deemed necessary to establish a journal on mathematical modeling in ecology within the CEMA system.

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## SCIENTISTS AND SCIENTIFIC ORGANIZATIONS

### COOPERATION IN SCIENTIFIC RESEARCH URGED

Moscow PRAVDA in Russian 23 May 79 p 1

[Editorial article: "Cooperation of Scientific Forces"]

[Text] A well thought out strategy of scientific research and the skill to concentrate forces and means for an all-out effort to meet the vital demands of production are important conditions for raising the role of science in communist building.

"The success of the scientific-technical revolution, its positive effect on the economy and on all aspects of life can be secured only through the efforts of scientists," noted Comrade L. I. Brezhnev at the 25th CPSU Congress. "A greater and greater role is being played by the inclusion in this historical process of all participants in public production, all links of the economic mechanism."

The strength of Soviet science lies in its unity with practice and life. The USSR Academy of Sciences is strengthening its ties with production. In the last year alone its institutions, with the participation of branch institutes and other organizations of 50 ministries and departments, submitted for realization over 1,400 studies and over 230 elaborations have already been assimilated by industry.

The academies of sciences of the union republics actively cooperate in solving important problems that especially affect the interests of large regions of the country. The scientists of the Ukraine, Belorussia and Moldavia, following a single coordinated plan, are studying the questions of the efficient utilization of natural resources and the conservation of the environment, of chemicalization in agriculture. The scientific institutions of Latvia, Lithuania and Estonia are studying the Baltic Sea according to a common program. The academies of sciences of the republics of Central Asia and Kazakhstan are working together in the area of seismology and earthquake-proof building. They are studying deserts, helping to put previously infertile lands into economic turnover. This type of organization of research is dictated by the necessity to solve comprehensively the problems of scientific-technical progress, and it should be more extensively utilized.

The precise management of complex research involving tens and sometimes hundreds of scientific and production collectives is a complicated matter. The outstanding accomplishments of our native space program and the successful realization of an international program for developing a single computer system in fraternal socialist countries show that in this regard valuable experience has been gathered and is deserving of careful study and creative application in other areas of science and technology. A number of branches are actively involved in improving the organization of research. Adjoining scientific collectives in the electrical engineering industry are working according to uniform orders, which simplifies the coordination of operations of those who are fulfilling the orders. Here financing is concentrated in the hands of the head scientific organization, thus encouraging the timely fulfillment of tasks. There are also other progressive forms enabling us to accelerate the development and assimilation of new technology. It is important to note them on schedule, to generalize them and to organize the exchange of experience. This in particular is the primary task of the All-Union Soviet of Scientific-Technical Societies.

During this five-year plan about 200 complex special-purpose programs will be implemented to solve the most important scientific and technical problems. The work is being done by various institutions and enterprises of different branches under the leadership of a head organization. The unification of forces on the basis of a specific plan is fully justified. Because of this new and effective means for mechanizing difficult and labor-consuming operations have appeared, electro-physical and electro-chemical methods of processing materials are being developed more rapidly and other successes have also been achieved.

At the same time there are still many problems in the work on a complex program. We are speaking in particular of the display of departmentality, of the imprecise interrelations of branches and their subdivisions. It happens that not completely perfected designs for machines are submitted for mass production. An example of that is the problems in the development of a system of machines and equipment for mechanizing the lumber industry. Scientific design organizations and the enterprises of the Ministry of the Lumber Industry of the USSR and of the Ministry of the Machine Building Industry still have not solved the tasks on the level of modern requirements of this technology. Head organizations and the USSR State Committee on Science and Technology, with the direct participation of which the complex special-purpose programs were developed, must more strictly control the course of their fulfillment while eliminating departmentalizing tendencies and encouraging high quality in elaborations. The system of financing and of material-technical and organizational supplies of such programs needs restructuring.

The progressive special-purpose program method of administration is becoming more widespread. In light of this there is an archaic quality to the practice still common in scientific institutions in which cadres,

means and equipment are dispersed and where each researcher is similar to a handicraftsman working alone at home involved only in his own subject. The interaction of VUZ's with academic and branch scientific institutions has not been organized everywhere. This results in the duplication of research. The USSR Academy of Sciences and the academies of sciences of the union republics must pay more attention to the responsibilities they have been given as coordinators of scientific work.

Socialist competition is a dependable instrument for improving interaction among scientific institutions and with production collectives. Thus, Khar'kov scientists together with machine builders decided to accelerate the development and assimilation of new technology. During 3 years of the five-year plan they organized the manufacture of 215 new types of machines, equipment and installations, mechanized and automated many production processes and saved about 300 million rubles. Many collectives of Moscow, Leningrad and other scientific centers exhibited similar initiative. Such patriotic initiative, having received the active support of party committees, effectively affects production progress.

It is very important that party organizations deal more thoroughly with problems which frequently arise during the joint efforts of various scientific and production subdivisions, effect the simplification of cooperative efforts and encourage the rapid achievement of the set goals. The concentration of forces of scientists and strengthening the union with practical experience raises the effectiveness of science. It is the duty of the communists of scientific institutions to creatively assimilate and more extensively disseminate the leading experience of research organizations in order to realize its fruit along the entire chain from idea to practical application.

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## SCIENTISTS AND SCIENTIFIC ORGANIZATIONS

### UKRAINIAN TRAUMATOLOGISTS AND ORTHOPEDISTS MEET IN KIEV

Kiev RABOCHAYA GAZETA in Russian 15 May 79 p 4

[Article by K. S. Ternovoy, Ukrainian SSR deputy minister of public health, professor, honored worker of science of the Ukrainian SSR, chairman of the organizing committee of the congress]

[Text] Today, the 15th of May, the Eighth Congress of Traumatologists and Orthopedists of the Ukraine is starting in Kiev. In that forum there will be discussions of vitally important questions of medical science and public health practice, ways to improve specialized care of the population and urgent problems in the prophylaxis and treatment of traumatism, affections of the large joints and inflammations of all bone layers.

The health of the nation is a national resource of our country. At the 25th CPSU Congress comrade L. I. Brezhnev emphasized that "among the social tasks there is none more important than concern about the health of the soviet people." The right to health protection is guaranteed by the Soviet Constitution. In the resolutions of the CPSU Central Committee and the USSR Council of Ministers regarding further improvement of the national public health service a complex program for improvement of the health service was defined. The course toward further expansion and reinforcement of specialized types of medical care is directed toward maximum satisfaction of the population with all types of medical aid, among which the traumatological and orthopedic occupy an eminent place and are acquiring great social importance.

Traumatism is one of the most vital problems of the present day. In the capitalist countries it occupies one of the first places among the causes of temporary and complete loss of working capacity and carries off millions of human lives. It is regarded as a social disaster, and so it is no accident that in those countries they call it the "plague of the present day." At American enterprises, for example, one worker dies every 37 minutes and one receives an occupational trauma every 16 seconds. At the industrial enterprises and construction sites of France, every 9 seconds there is an accident that causes temporary, and every 2 minutes--complete incapacitation, and every hour there is an accident with a lethal outcome. Such are



the facts. But bourgeois scientists do not reveal the social reasons for the growth of traumatism, asserting that the depraved neuro-psychic state of the worker is a "potential culprit in accidents." Consequently, the struggle against traumatism in the countries of capital has been and remains unrealizable, for the capitalist order and the interest of the nation in the improvement of working and living conditions and the reduction of traumatism are incompatible.

The Soviet Union is the first country in the world in which problems of traumatism and its prevention have become state problems. A harmonious system of trauma prevention has been created, one which embraces different ministries, departments and social organizations. In the provision of trauma prevention and treatment the role of medical workers and especially of traumatologists and orthopedists is exceptionally great.

During the years of soviet power traumatology and orthopedics formed into an independent branch of medical science and practice. A wide network of outpatient polyclinical institutions and specialized traumatological and orthopedic divisions of hospitals has been created in our country. About 22,000 traumatological and orthopedic beds have been installed in the republic, and 767 specialized consulting-rooms are functioning in polyclinics. A new type of polyclinic institution has arisen in the oblast centers and large industrial cities--traumatological stations that do much medical work and have become real methodical centers in the struggle against traumatism in production and in ordinary life. In the Ukraine 74 round-the-clock traumatological stations are functioning. By next year it is proposed to open 78 more such traumatological stations in industrial cities. In orthopedic and traumatological institutions of the republic over 2500 physicians are working, giving all their forces, knowledge and experience to the struggle against traumas and injuries, the struggle for the health and life of man.

In its decisions regarding preservation of the people's health the Communist Party has always advanced the principle of prophylaxis and has defined it as the leading one in the development of soviet medicine. The CPSU program envisages that "at all enterprises modern means of safety engineering will be introduced and sanitary and hygienic conditions assured which will eliminate production traumatism."

In the last 5 years a reduction of occupational traumatism has been achieved in the republic: agricultural by 10.5 percent and industrial by 4 percent.

The development of effective measures to reduce traumatism is at the center of attention of public health agencies. In the program of the congress, urgent problems of affections of the locomotor system and open injuries of large joints are presented for creative discussion. Methods of treating bone fractures and their consequences and complications that were used quite recently, such as, for example, plaster-of-Paris bandages, constant traction by a load and knitting, do not satisfy us now. For during such treatment people are bed-ridden for long months, undergo severe operations and are far from always restored to complete health.



Soviet traumatologists and orthopedists have theoretically substantiated, developed and widely introduced into practice excellent methods of treatment which have assured favorable conditions for the regeneration of bone tissue, treatment of injuries and diseases of bones and restoration of lost function of extremities. Effective medical devices have been created-- intersecting wires, metal rings, connected rods, etc. Now by means of apparatus developed by Lenin Prize winners Ilizarov, Gudushauer and Kalnberg legs are strightened and lengthened by 10, 20, 30 and even 50 centimeters, and the form is also changed and defects compensated by a bloodless method. These new highly effective procedures for the treatment of injuries and diseases of the locomotor system have opened up new horizons for restorative surgery and have permitted reducing the treatment periods of patients by seven eighths or more, considerably improving the outcomes and returning health to patients earlier considered incurable. A sharp reduction of temporary and permanent invalidism has been successfully achieved.

These progressive methods of bloodless treatment are being widely introduced in the Kiev, Khar'kov and Donetsk institutes of traumatology and orthopedics and in medical institutions of Odessa, Krivoy Rog, Lutsk and many other cities. Our physicians have restored functions of the hand or foot to thousands of persons and have helped them to discard crutches or prostheses, to wear normal footwear and stand in a labor formation.

But the achieved successes do not set the scientists' minds at rest. The medical scientists and physicians of the republic, especially those of the Kiev Scientific Research Institute of Orthopedics, which today is celebrating its 60th anniversary, are mastering the technique of transplanting joints, tubular bones and even whole bone segments in the presence of defects arising after trauma, the removal of tumors, etc. Kiev Professor Ye. T. Skiyarenko has been awarded a State Prize of the Ukrainian SSR for the development of new methods of treatment of patients with infectious nonspecific polyarthritis.

In the Khar'kov Scientific Research Institute of Orthopedics and Traumatology imeni M. I. Sitenko, under the leadership of its director, corresponding member of the USSR Academy of Medical Sciences, Professor A. A. Korzh, the application of prosthetics directly on the operating table has been scientifically substantiated and done. That method of rapid application of prosthetics of the extremities makes it possible to return to active life half a year earlier than usual. Now that system is being introduced in all oblasts of the Ukraine. Professor A. A. Korzh has been awarded a State Prize of the USSR for the experimental substantiation, clinical development and introduction into medical practice of a highly effective method of transplanting large bone allotransplants in man.

Leading specialists of almost all the union republics, Moscow and Leningrad are participating in the work of our congress. This is not only an acknowledgment of the great contribution of Ukrainian traumatologists and orthopedists but also symbolizes the unity of the scientists and practical physicians of the fraternal republics. Scientists of Bulgaria and the GDR will

share their work experience and become acquainted with our gains at the congress, thus reinforcing our scientific contacts and creative collaboration.

Enriched with new ideas and the experience of colleagues, the traumatologists and orthopedists of the republic will return to their clinics in order to vigilantly conduct the noble watch of sentries of health.

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ULTRASTRUCTURE OF CHLORELLA PYRENOIDOSA CELLS (STRAIN g-11-1) FOLLOWING GROWTH UNDER CONDITIONS OF A PROLONGED SPACE FLIGHT

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[Article by Academician of the Academy of Sciences Ukrainian SSR K.M. Sytnyk, Ye.L. Kordyum, O.L. Mashyns'kyi, A.F. Popova, and H.M. Hrechko, Institute of Botany, Academy of Sciences Ukrainian SSR, Kiev]

[Text] The ultrastructure of a cell is a sensitive indicator of the effects of space flight on the growth and viability of the unicellular alga *Chlorella pyrenoidosa*; consequently, this parameter was employed in studying the growth of *chlorella* aboard the space station Salyut-6 under the unique conditions of a 28 day flight. The observations were performed on strain g-11-1, a pigmented mutant of *Cl. pyrenoidosa*, which was grown in an IFS-2 apparatus under heterotrophic conditions (organic medium, darkness). The nutrient medium was inoculated aboard the orbital station; the microorganisms were prefixed with 1.5% formaldehyde immediately on landing. The prefixed cells were collected on Synpore membrane filters which were imbedded into agar cubes to avoid losses and, in this state, were subjected to further processing. The cells were fixed with 3% glutaraldehyde at pH 6.8 for 2 h, and then in 1% OsO<sub>4</sub> for 3 h at room temperature. Dehydration was carried out in the usual manner; the preparations were then flooded with epon. Sections were prepared on an LKB ultratome and stained with uranyl acetate and lead citrate for examination with a JEM-100B electron microscope. A morphometric approach was taken in determining the volume relationships of organelles of the control and experimental cells.

The compactness of the experimental cells was 4.5 times as great as that of the control cells. The control and experimental populations were heterogenous with respect to both, the cellular dimensions and cell condition. The cell populations were divided into three classes: I -- young cells (autospores), newly produced from maternal cells; II -- mature cells; and III -- mature undividing cells with features of "gigantism".

In each population an enumeration was made of the normal cells, partially vacuolized cells (50% of cell volume occupied by vacuoles), highly vacuolized cells (over 50%), and nonviable cells (contents completely degraded). A separate count was maintained for cells in various stages of autospore formation. The results of enumeration (using 800 cells for each determination) showed that the number of normal experimental cells was significantly smaller than normal control cells. In the experimental group class I cells predominated (94.2%), while in the transport control group they accounted for 80.3% of the cells, and for 68.6% of the cells in the laboratory controls. Class I cells in the experimental group con-

tained only 2.6% normal cells, 15.2% partially vacuolized cells, 67.6% highly vacuolized cells, and 14.6% nonviable cells; the respective figures for the transport control cells were 66.9%, 19.8%, 1.4%, and 11.9%, and for the laboratory controls the corresponding figures were 83.6%, 8.4%, 0%, and 8.0% (Fig. 1). The experimental series contained virtually no dividing cells or cells with autospores; in addition, their numbers were insignificant in the transport (1.7%) and laboratory (1.4%) controls.

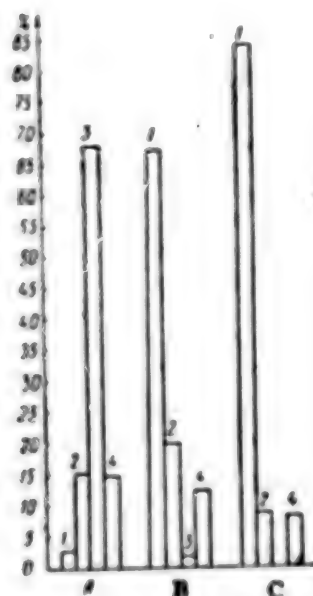


Fig. 1. Distribution of class I cells in the experimental and control groups. 1 -- normal cells, 2 -- up to 50% vacuolization, 3 -- 50 to 90% vacuolization, 4 -- nonviable cells. A -- experimental, B -- transport control, C -- laboratory control.

Since class I cells predominated in the experimental group they shall be considered in more detail.

The ultrastructure of the normal class I cells in the experimental and control groups is generally typical of the mutant g-11-1 strain (Fig. 2a; Fig. 3a). The cells contain a nucleus, a plastid, mitochondria, Golgi apparatus, endoplasmic reticulum, vacuoles, and lipid droplets. The oval shape of the young *Chlorella* cells, i.e., those that have just been produced from maternal cells, eventually becomes round. During vacuolization and cytoplasmic lysis cell shape may vary.

Plastid configuration in the cells of the pigmented mutant is irregular.

Plasmid membranous system in young cells contains numerous vesicles of various shapes and dimensions. Lamellae appear to be isolated in the sections or are entirely absent. The stroma of a plastid of average electron density contains starch granules of various shapes and sizes, osmophilic globules which vary in number depending on the section, and ribosomes. The electron lucent areas of the plasmid contain DNA fibrils. In mature cells plasmid vesiculation decreases while the number of lamellae per section increases. Plasmids of the pigmented strain g-11-1 contain pyrenoid, the shape of which and the matrix structure differ from the pyrenoid of autotrophic strains. Strain g-11-1 pyrenoid has less well delineated contours and not as dense a fibrillar-globular matrix which is not separated from the ribosome-containing cytoplasm. The pyrenoid is perforated with one or two lamellae, the internal part of which is filled with a material showing intermediate electron density, in distinction to the stromal lamellae (Fig. 2 b and c). The long axis of the pyrenoid is 0.2-0.6  $\mu$ m. The dimensions and shape of the amylogenic zone along the pyrenoid are variable. The number of starch granules in the plastids of mature cells is increased.

Data which indicate that the pyrenoid protein of green algae functions as a depot for photosynthetic proteins [1] is in agreement with the differences in pyrenoid structure in heterotrophic and autotrophic strains. Only individual cells in the experimental group possessed "undeveloped" pyrenoid, the size of which was smaller than that of the pyrenoid of plastids in control cells. There is no amylogenic zone around such pyrenoids or it is weakly expressed. In the majority of the sections of plastids of experimental cells we did not observe pyrenoid proteins.

In the young and mature control and experimental cells we noted, particularly, flexibility of the plasmalemma with formation of various configurations which were oval, round, loop-shaped (Fig. 2c), myelin-like, etc., and appeared between the plasmalemma and the membrane as well as in peripheral portions of the cytoplasm. Previously, layering of the plasmalemma has been described only in the case of *Chlorella* autospores [2]. Local autolysis of the cytoplasm was also noted.

Experimental and control cells differed with respect to the relative volumes of a number of cytoplasmic organelles and storage substances (lipid droplets, starch in plastids) (Fig. 4). The relative volume of lipid droplets was increased in the experimental cells (Fig. 3, b and c), while the area of the Golgi apparatus and the amount of starch in the plasmids decreased. The relative volumes of nuclei and mitochondria did not differ in the experimental and control cells. The nuclei of experimental cells rather frequently show condensed chromatin, which is largely localized on the periphery of the nucleus (Fig. 3d). Certain membranous formations were also noted in experimental cells, largely in vacuoles, which may have been related to autolysis.

The present study revealed certain differences between control and experimental cells in the ultrastructure and volume relationships of cytoplasmic organelles and storage material; these differences reflect metabolic changes in cells grown under conditions of space flight. In addition to





Fig. 2. Electronmicrographs of control cells: a and c --general view at x28,000 and 33,000, respectively; b -- plastic fragment with pyrenoid, x110,000, d -- fragment of peripheral area of cell, x90,000.



Fig. 3. Electronmicrographs of experimental cells: a and c -- general view at x28,000 and 33,000, respectively; b -- plastid fragment with pyrenoid, x110,000.

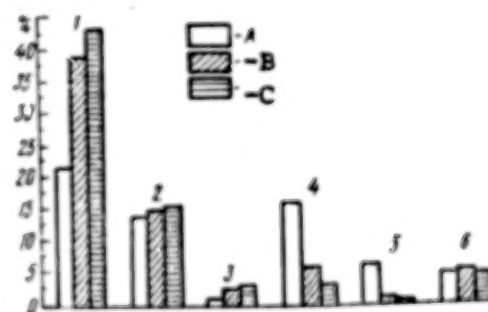


Fig. 4. Relative volumes of organelles and storage materials in experimental and control cells: 1 -- plastid; 2 -- nucleus, 3 -- Golgi apparatus; 4 -- vacuoles; 5 -- lipid droplets; 6 -- mitochondria. Annotations as in Fig. 1.

accelerated accumulation of biomass, the experimental cells also experienced accelerated ageing as indicated by the information gained from electron microscopic examinations. Thus, prolonged space flight exerts a significant, multifaceted, influence on the growth and viability of physiologically active chlorella cultures.

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